MONTHLY BULLETIN

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

(ENGLISH EDITION)

PUBLISHING and EDITORIAL OFFICES: 231, RUE ROYALE, BRUSSELS.

Yearly prepaid subscription { **Belgium . . . . . 70 Belgas** / **Other countries . . 75 Belgas** } including postage

Price of this single copy: 8 Belgas (not including postage).

(1 Belga = 5 Belgian francs.)

Subscriptions and orders for single copies (January 1931 and later editions) to be addressed to the General Secretary, International Railway Congress Association, 231, rue Royale, Brussels (Belgium).

Orders for copies previous to January 1931 should be addressed to Messrs. Weissenbruch & Co. Ltd., Printers, 49, rue du Poinçon, Brussels.

Advertisements: All communications should be addressed to the Association, **231, rue Royale, Brussels.**

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OF THE

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Editions in **French** and in **German** are also published.

Vol. XX. — No. 2. February 1938.

BULLETIN

OF THE

INTERNATIONAL RAILWAY CONGRESS

ASSOCIATION

(ENGLISH EDITION)

[385. (06. 112]

THIRTEENTH SESSION

Paris, 1-12 June 1937.

GENERAL PROCEEDINGS

2nd Section : LOCOMOTIVES AND ROLLING STOCK.

INAUGURAL MEETING

June 2nd, 1937.

PROVISIONAL CHAIRMAN : DR.-ING. EH. J. DORPMÜLLER,
MEMBER OF THE PERMANENT COMMISSION OF THE ASSOCIATION.

— The Meeting opened at 9 a.m.

The Chairman. — Gentlemen, the Permanent Commission of the Association requested me to preside over the inaugural meeting of the 2nd Section, and proposed, as President, Prof. Dr.-Ing. V. WECHMANN, who — I am pleased to say so — is particularly competent to speak on the questions on our agenda. *(Applause.)*

Gentlemen, among the questions we have to examine, we find the following :

1. Evolution of the rail motor car as regards its construction, and special investigation into the transmission and brake questions. Comparative methods of testing railcars. Detailed investigation into the

costs of railcars and the methods of reducing them..

2. Recent improvements in steam locomotives of the usual type and tests of new designs (high-pressure reciprocating locomotives and turbine locomotives) as regards construction, quality of materials used, efficiency, working conditions, maintenance and financial results. Testing locomotives at locomotive experimental stations, and in service with dynamometer cars and brake locomotives.

3. Methods and devices used, in connection with electric traction, to save current between the supply side of the power station and the driving wheels (feeders, substations, tractors), and in particular the use of mercury rectifiers.

Your Section has, furthermore, to examine jointly with the 3rd Section, Question IX, worded as follows :

Results obtained from the automatic and distant operation of signals and points, and from locomotive cab signals.

The question which, in my opinion, appears to be of exceptional importance, is Question VI, in connection with electric traction. Your President, Prof. Wechmann, is a specialist in this matter. I feel sure your Section will make every endeavour to further the objects which the Railways concerned have in view.

To conclude, I wish your work to be quite successful, and I now give up the Chair to Prof. Wechmann, President of the 2nd Section.

— Prof. Dr.-Ing. Wechmann then took over the Chair.

The President (in German). — Gen lemen, I feel greatly honoured by bein chosen as the President of the 2nd Sec tion whose task is to investigate the ques tions relating to motive power and rol ing stock.

I shall preside over your debates to th best of my ability, so that all Railwa Administrations may profit by our com mon work. To this end I must rely o your kind co-operation. Consequently earnestly beg Delegates to take part in th discussions, so that, thanks to our ex change of views, each of us may gath copious information of a scientific an technical nature, with an eye to his fu ture work.

I will now propose as *Vice-Presidents*

Messrs. P. KOLLER, Chief Mechanic Engineer of the Czechoslovakian Sta Railways;

W. HUPKES, Chief Mechanical Eng neer, Netherlands Railways;

O. STORSAND, Manager, Norwegian Sta Railways;

O. H. MUNCK, Chief Mechanical Eng neer, Danish State Railways,

and as *Principal Secretary*, Mr. CHA TRELL, Engineer, of the Belgian Nation Railways Company. *(Applause.)*

— Following the proposal of the *Pres dent*, the Section then completed its B reau and drew up a provisional agend

— The Meeting was then closed.

* * *

Revision of the Rules and Regulations of the International Railway Congress Association.

— The Meeting was resumed at 9.20.

The President. — Before dealing with our agenda, we have to reach a decision as to the proposed alterations to Articles 2 and 4 of the Rules and Regulations of our Association.

— *The President read out the proposed modifications* (*).

I personally see no objection to these alterations being approved, and I think the Section will agree with me on this subject.

— *The Section unanimously voted the proposal.*

The President (in German). — In accordance with article 21 of the Rules and Regulations, we have also to appoint a Delegate on the Special Committee who will examine the proposed modifications.

Mr. Koller, *Vice-President.* — I think I will voice the feelings of the whole Meeting in proposing that Prof. Dr.-Ing. WECHMANN be appointed. *(Applause.)*

The President (in German). — I thank the Meeting for this special mark of sympathy and I willingly accept to carry out this duty.

— The 2nd Section then met jointly with the 3rd Section (Working) for the discussion of Question IV.

(*) See wording of the proposed alterations in the September 1937 number of this *Bulletin*, p. 1962 (Summary of Proceedings, Paris Congress, 1937), and revised Rules and Regulations in the January 1938 number, p. 98.

[621. 43]

QUESTION IV.

Evolution of the rail motor car as regards its construction, and special investigation into the transmission and brake questions.

Comparative methods of testing railcars.

Detailed investigation into the costs of railcars and methods of reducing them.

Preliminary documents.

Report (North and South America, China and Japan), by E. WANAMAKER. (See *Bulletin,* April 1937, p. 857, or special issue No. 26.)

Report (Germany, Austria, Bulgaria, Denmark, Egypt, Finland, Greece, Hungary, Norway, Poland, Rumania, Sweden, Switzerland, Czechoslovakia, Turkey, Jugoslavia), by Herr STROEBE. (See *Bulletin,* May 1937, p. 1281, or special issue No. 35.)

Report (Belgium and Colony, Spain, France and Colonies, Great Britain, Dominions and Colonies, Italy, Luxemburg, Netherlands and Colonies, Portugal and Colonies), by L. DUMAS and J. LÉVY. (See *Bulletin,* May 1937, p. 1363, or special issue No. 36.)

Special Reporter : L. DUMAS. (See *Bulletin,* June 1937, p. 1521).

SECTIONAL DISCUSSION.

Joint Meeting held on June 2nd, 1937,

by the 2nd and 3rd sections.

PROFESSOR DR.-ING. WECHMANN IN THE CHAIR.

The Meeting was opened at 9.30 a.m.

The President (in German). — We are now going to discuss Question IV, which is the first subject on our agenda.

Mr. Dumas, the Special Reporter, will open the proceedings.

Mr. Dumas, *Special Reporter* (in French). — Gentlemen, it would seem that the chief characteristic of the modern railcar is its high average speed, an average speed due to its high maximum speed, its great power of acceleration, and excellent braking power.

To solve the various problems arising, the great Railways, with the assistance of the builders, have adopted in recent years certain solutions, perhaps not altogether final, but at least already very satisfactory.

These problems of maximum speed, acceleration and braking have therefore

been solved technically, and these technical solutions are available to the Railways.

Maximum speeds of 140 to 160 km. (87 to 100 miles) an hour have been reached in many countries in actual working. Accelerations giving a speed of 80 km. (50 miles) an hour in 50, 60 or 70 seconds are current practice, and stops within the minimum distances determined by the adhesion are nowadays within the reach of everyone.

Consequently, I consider that these basic problems have been satisfactorily solved during the last few years, and that at the present time new problems have arisen as regards making the evolution of the railcar completely satisfactory from the operating point of view.

These new problems essentially include the problem of comfort and the problem of economical maintenance. They also include that of increasing the capacity of railcars to make it possible to replace steam trains by railcars, whether they are fully used or badly frequented.

Finally, besides these problems which affect only the Rolling Stock and Traction Department, there are no doubt problems concerning the permanent way, as well as the working, for all of which the Departments concerned are now endeavouring to find solutions.

Permanent way problems : adaptation of the track for the high speeds attained by railcars; operating problem : modification and adaptation of operating methods.

These considerations led me to word *Summary 1* as follows.

1. Satisfactory technical solutions have been found in the course of the last two or three years to the speed, acceleration, braking and safety problems.

The future of the railcar now depends on the solutions that will be adopted as regards comfort, economical maintenance, and capacity. This future also depends on future improvements of the track (curves, superelevation, elimination of rail joints or reduction of their number) and on the adaptation of the operating methods to the rail motor car.

The President (in German). — Does anyone wish to say anything about Summary 1 which has just been read?

Mr. Le Besnerais, *French Nord Railways* (in French). — Mr. President, I think it would be very interesting to have some additional information about what has already been done in certain countries to adapt the operating methods to the railcar, or more exactly I think, the mutual adaptation of the railcar and operating methods, seeing that they must both take each other into account.

From this point of view, and moreover as it says in the special report, the railcar is not only intended to replace trains on secondary lines, but attempts are being made more and more to use it on main lines to replace fast or express trains.

Very often, owing to the still insufficient capacity of the railcar, this requires several services to be run, and then the operating methods are affected as the replacement can either be done by two services at the same time as the old train, or the services can be spread over the day in a different fashion.

This may affect the railcar itself, as the question of increasing its capacity will be of greater or less importance according to whether the services are to be run at a given moment or spread over a greater part of the day.

On the French railways we have already had some experience both of the

problem and of the difficulties that arise in trying to solve it, and we would be much obliged if foreign Railways confronted with the same problem could give us some idea of the way in which they have gone to work, the difficulties they have experienced, and the solutions they have adopted to overcome them.

Mr. Renevey, *Algerian Railways (Joint management)* (in French). — The question just raised by Mr. Le Besnerais gives us the opportunity to stress a point which I should like to see examined before we discuss the summaries. An agreement should be reached about the terms used.

Our very competent Reporter has used the term « autorail » (railcar) in his special report instead of « automotrice » (rail motor coach).

The word « automotrice » was formerly used to replace the word « voiture » (coach), a rail motor coach being considered as a passenger coach equipped with a motor.

Nowadays this word has been given a much more general meaning, and if sets of two or three vehicles can still be called railcars, I think there is some difficulty in applying this word to the much larger units, such as the American trains mentioned in the reports.

In Mr. Wanamaker's report, for example — as everyone, moreover, was able to learn from the technical press — mention is made of the construction of certain trains in America, called « autorails » (railcars), which consist of three diesel locomotives and seventeen coaches.

I think it would be as well to define the limits of the word « railcar » because a set of 3 locomotives and 17 coaches should be called a train.

The P.L.M. for example has under construction two double-unit diesel locomotives, each of 4 000 H.P., which will probably be used on the Paris-Nice line.

When the trains are hauled by this type of diesel locomotive instead of by steam locomotives, I do not think they will turn into railcars.

In fact a definition must be found for the railcar.

The President (in German). — I should like the delegates to express an opinion on the question raised by Mr. Le Besnerais first of all.

Mr. Sakr, *Egyptian State Railways.* — With regard to the first point of the summary, I should like to state that the reliability of the railcar is of equal importance as speed. I should like to know if any information has been gathered as regards failures and breakdowns of railcars whilst in service, per 100 000 kilometres run, as compared with a corresponding steam locomotive which works the same service, and if so, particulars of the delay to traffic.

Dr. Leibbrand, *Deutsche Reichsbahn* (in German). — If I have understood him aright, Mr. Le Besnerais wanted to know the results obtained when replacing heavy steam trains by railcars.

We have done this on a large scale, in concentrated services, above all services between large towns, as well as in districts with little traffic, such as the south and east of Bavaria. When we tried to replace heavy steam trains by light trains between the 7 large towns of the Ruhr Valley, with an average of half a million inhabitants, various experts said it would be impossible to do so as the traffic was concentrated at certain hours during which even the heavy trains were overloaded, and it was not possible to consider spreading the traffic over the whole

ay in a more uniform manner by the se of small units.

The experiment was tried, however, nd the results were excellent. It is true at at the beginning railcars were not sed, but small steam trains, usually consting of only three coaches, because we ad not got a sufficient number of railrs. As much as possible the trains follved a standard timetable, i.e. were run regular intervals. Doubtless it is imossible to introduce such a timetable in uniform way everywhere, because there are only a few lines where special oads can be reserved for the light trains, nd so the standard timetable for the ght trains is upset by the timings of the ng-distance trains, particularly the exess trains.

We are going systematically to replace eam trains by railcars and we intend to troduce the same method of working other districts with heavy traffic, for ample between the towns of Frankfort-n-Main, Mayence, Wiesbaden and Darmadt. The operating costs are slightly gher, as many light trains for all that e still rather more expensive than a w heavy units. But the receipts have creased still more, so that taken as a hole the financial results are satisfacry.

In the Ruhr Valley there are 200 to 0 seats in each small steam train. Conquently a single railcar will be insuffient to replace a train, but a trailer will ve to be added; in services which pick a lot of traffic, 2 railcars will have be coupled together with 2 trailers.

The long-distance traffic worked by ilcars requires to be organised on very fferent lines from this short-distan traffic. We have put into service me fast railcars with a maximum eed of 160 km. (100 miles) an hour between Berlin and other large German towns, such as Hamburg, Munich, Stuttgart, Frankfort-on-Main, Cologne and Breslau. The distance may be as much as 650 km. (404 miles). The timetables are so arranged that it is possible to get to Berlin during the morning, and return home in the evening. This means that 1 300 km. (808 miles) must be covered during the day and enough time be left between the two journeys to do business in the capital. These new services have been much appreciated by the public, but the railcars have the drawback of a limited number of seats. Consequently special high rates have had to be charged and seats must be booked. These railcar services are consequently not a completely satisfactory solution, and we do not propose to replace our long-distance express trains by railcar services on a large scale. As soon as we have locomotives available to work these services about as quickly as the railcars, we will again use trains hauled by locomotives for long-distance services with important traffic. The railcars are not intended to replace the existing express trains, but to complete the services. They will continue to be of great use in the future wherever the heavy trains hauled by locomotives are not used to a sufficient extent because the traffic is too small, and consequently they will be used during those hours of the day when a fast long-distance service is needed but there is less traffic, or for services to places between which there is no fast long-distance service at the present time. In this way it will be possible to give medium-sized German towns the benefit of long-distance services, thereby meeting one of the urgent needs of the present.

In addition to using railcars in heavy suburban traffic, as in the Ruhr Val-

ley, and to supplement the heavy trains in long-distance traffic properly speaking, the Reichsbahn, like many other railways, has found them a great success in the case of the light traffic in thinly populated districts, and the results have been just as good here as elsewhere. When changing over from steam to railcars, the transport of luggage, packages, express parcels and mail has sometimes given rise to difficulties. Some railcars were too small, and the engines were not sufficiently powerful for a goods wagon to be coupled up if needed. Consequently we have used more powerful engines and enlarged the luggage compartments of our railcars. This has quite overcome the original difficulties.

Mr. J. Lévy, *Reporter* (in French). — I want to answer the question raised just now by Mr. Le Besnerais, as well as Dr. Leibbrand's very complete and clear statement.

On the French State System, which is a system with a very scattered population — the case which Dr. Leibbrand also had in mind — the railcar has also been used very widely, either to replace little used small trains or, on the contrary, together with heavy trains, like the experiment made in 1936 on the Paris-Havre line where there is a large town at each end of a 200 km. (124 miles long) line, with an intermediate large town, Rouen, and towns of secondary importance on the way.

Through high-speed services worked by railcar were introduced between Paris and Havre; in addition services with a stop at Rouen and two or three stops between Rouen and Havre were worked by heavy steam trains. Other heavy trains were run between Paris and Rouen with two or three intermediate stops; finally at the other end of the scale there are railcars working a shuttle service with stops at the small stations.

This system, like on the Reichsbahn, has attracted quite a lot of custom to the railway.

Services have been speeded up, either thanks to the railcar alone, or by combining express train and railcar services, for example an express between Paris and Tours and a railcar service between Tours and La Rochelle; like Dr. Leibbrand reported just now, this makes it possible to travel from Paris to La Rochelle and back in the same day, a distance of about 400 km. (250 miles) in each direction.

One of the issues raised by Mr. Le Besnerais' question is as follows : if the railcar can meet the average daily traffic, what will happen on what are known as « peak » days, such as Sundays in summer and holidays, when the number of passengers is very greatly increased.

Our experience last year was that on such peak days we had to leave nearly all the railcars in the depots and replace them by express steam trains to keep to the timetables, and this happened just when our steam locomotives and passenger stock were already heavily used elsewhere.

Such a situation gives rise to great inconvenience, and in some countries has greatly hampered the development of the railcar.

Consequently it was imperative to solve this problem.

We have tried one solution which seems to be satisfactory.

The use of railcars alone occasions difficulties in view of their small capacity; obviously several railcars could follow one another over the same line, but this gives rise to other operating diffi-

culties : the drawback of increasing the number of train workings, level crossings, etc.

First of all we tried to find a solution by ascertaining the number of persons using these services, which made it possible to know when the railcar with 80 or 100 seats had to be replaced by trains with 300 or 400 seats and when it was sufficient merely to double or treble the number of railcars.

This done, by grouping the railcars on the lines where the increase in traffic was the smallest, and replacing them by trains on the other lines, a new allocation of the railcars was obtained for each centre or several neighbouring centres, enabling them to be used on holidays, and the needs of the public met on the lines where the capacity of the railcars was insufficient.

To do this without increasing the number of train workings it was necessary to couple the railcars together, and here technical knowledge came to the assistance of the operating problems.

We now group our railcars in two ways : there are first of all the vehicles which can be coupled together and driven by a single driver in the leading railcar, remote control being electrical or by means of compressed air and electro-valves; another combination is to use two railcars which cannot be coupled together, but the drivers of which can see each other, the brake being worked by one of them, while the leading driver has a simplified code of signals the second driver must obey.

Both these systems have given good results, so that during our last peak period we were able to make use of all our railcars, grouping them together on lines with increased traffic, and replacing them by trains on lines with heavy traffic.

To elucidate the point just raised by Mr. Renevey, I think the term « autorail » (railcar) should be given a meaning rather like that of the unit in the case of electric traction. For our suburban traffic from Paris St. Lazare for a long time we have used electric trains composed of 1, 2 or 3 units, according to the hour of day; it appears that the main characteristic of the electric motor coach is the fact that it can be driven either as a single unit or coupled up.

In the same way, the main characteristic of the railcar is the fact that if need be 1, 2 or 3 railcars can be coupled together.

Mr. Koller, *Vice-President*. — In reply to Mr. Le Besnerais, I would like to report that on the Czechoslovakian State Railways, on the main lines and in the case of express trains where the number of passengers is not excessive but varies within rather wide limits, we have for some years adopted the classic solution of running a railcar together with one or two trailers. The coupling is of the ordinary type, and in this way we get a little diesel train.

According to circumstances the railcar is used by itself, or with one or two trailers. The complete train of this type, which is known as the « Blue Arrow », therefore consists of three coaches and there are about 220 seats, which meets our traffic requirements. On days with heavy traffic, two trains of this kind can be coupled together electrically.

The engine power is from 400 to 500 H.P. We propose to increase the power to about 600 H.P. by supercharging.

The speed of these trains is 100 km. (62 miles) an hour.

Our initial difficulty was the rather unsteady running of both the railcar and the trailers.

To-day after several years' experience, we have evolved a design giving complete satisfaction.

The weight of the railcar is about 50 tonnes (49.2 Engl. tons), and that of the trailers about 33 tonnes (32.5 Engl. tons): the latter are therefore rather heavy, and the number of seats is about 75 per vehicle.

The cost of such a train is only about two-thirds of that of a steam train of the same capacity.

We propose to use similar trains, but of lighter construction, for local trains of average capacity on the main lines.

For this purpose, in 1936 we ordered two new types of railcar, each the first of a series, one with electric transmission and the other with electro-mechanical transmission on the Sousedik system.

Mr. Barata, *Portuguese Railways Company* (in French). — I have followed with great attention and much interest what Dr. Leibbrand and Mr. Koller have said.

I had the opportunity of travelling in France and Germany to study their railway practice, and unless I am mistaken, on the French State Railways railcars are used not only for the main line services but also as feeders for the steam trains.

I should be particularly interested to have some information from Mr. Lévy on the part played by railcars in collecting traffic for the steam trains; I would like to know if the results obtained on his system have been satisfactory, and in particular if the cost price, for the railcars as a whole, is less than that of the steam trains formerly used.

The President (in French). — I would like to point out to Mr. Barata that the question of the operating costs is the subject of point 7 in the Summaries and will be examined later on.

Mr. Hupkes, *Vice-President* (in French). — I would like to tell the Meeting about the results obtained by the Netherlands Railways with their triple railcars.

For some years we have had 40 diesel-electric sets in service.

In our little country where the towns are very near together, it is not only necessary to have trains of varying capacity, but it must also be possible to divide up or combine trains in service regularly.

With this object in view our trains are fitted with automatic couplings so that the train can be coupled up or split up on the way, and in addition a train of several sets can be driven by a single man.

Our present services are worked by means of trains of one, two, three and four sets. A train of four sets consequently consists of twelve coaches. Each set has 160 seats so that there are 640 seats in a train of four sets.

These services have been worked for some years, and up to the present no difficulties have occurred.

Mr. Dumas (in French). — To sum up the remarks made by the different speakers, we find that the question of increasing the capacity of railcars and that of working such services have received special attention from the Railways.

Dr. Leibbrand told us that in Germany the railcar is systematically used for short and average distances, and that there is a tendency in the case of very

g distances to replace multiple-unit lcars by trains during the periods h the heaviest traffic, while the mul-le-unit railcars work additional servi- during the slack hours. This is the ichsbahn's point of view.

Other Administrations have expressed ferent opinions.

The Czechoslovakian State Railways nk that the best solution is to use a fficient number of trailers and even rease the power of railcars to meet all increases in traffic, and that it is good plan to group two or three little s formed in this way into trains dri- by a single man.

Mr. Hupkes, the Netherlands Railways' egate, going even further, states that Holland steps have been taken to sys-natically obtain sets made up to two, ee of four triple-unit railcars driven a single man, i.e. sets of very large pacity.

n the United States, according to Mr. anamaker's report — and we all re-t the absence of Mr. Wanamaker him-f very deeply — at the present time ltiple railcars of 12 coaches or more used to replace complete trains.

n view of these facts, we think we re well advised to include in the first agraph of the summaries the question the capacity and that of the adapta-n of the operating methods to the lcar; these questions are very much the fore at the present time, and they uld be studied very carefully.

Under these conditions, I suggest to Meeting that Summary 1 be main-ned but slightly altered as regards the line, as follows : « ... and the adap-on of the railcar and the operating thods. »

Dr. Leibbrand (in German).— I would to state that when I spoke just now about heavy trains hauled by locomotives, this can refer to both steam and electric locomotives.

Mr. Palmieri, *Italian State Railways* (in French). — I would like to go back to the question raised just now, and make one or two remarks about the railcar services on the Italian Railways.

For a long time the question of introducing railcar services has been under consideration in Italy. Such services have been introduced both on secondary lines, and on the main lines.

On the secondary lines the object in view was to solve the problem of lines with very little traffic; on the main lines we wanted to speed up the services between places lying very far part.

In the case of the main lines, we have put railcars into service over distances of 250 km. (155 miles) and even 300 km. (186 miles), for example between Rome and Ancona, Milan and Venice, Venice and Trieste, and Venice and Bologna.

Recently we put into service two electric trains, consisting of three motor units and known as « electro-trains », which work between Naples and Bologna.

On the trial runs recently made, these trains reached a speed of 192 km. (119.3 miles) an hour as their maximum trial speed. The speed in service is 160 km. (100 miles) an hour. The run between Rome and Florence, a distance of 318 km. (197.6 miles), is made in about 3 hours, but account must be taken of the fact that this is a line with many curves and gradients.

As regards the capacity of railcars, to meet peak traffic requirements we have not considered running several railcars one after the other, as in our opinion this makes the working too difficult, but rather coupling up railcars together. In the case of the old units in service, we

are coupling them together, each being driven separately.

In the case of new types, we couple up two vehicles and drive them from one end or the other.

With this system, we think we can meet all peak traffic requirements when the operating conditions do not allow for all the services during the day being worked by railcars. During the rush hours we use steam trains, and the railcars are kept in reserve for periods with less heavy traffic.

Mr. Nicolet, *French State Railways* (in French). — I agree with the general principles of the proposed summaries, but I do not think they are sufficiently forthright in the case of the question we have been discussing this morning.

The most important question is how the railcar is used.

Consequently, I think that after having stated that satisfactory solutions have been obtained in the case of the problems of speed, acceleration, braking and safety, it should be explicitely stated that the future of the railcar depends upon investigating and perfecting the operating conditions, which should be defined very methodically, taking into account the particular requirements of each district and each kind of traffic.

Mr. Renard, *French Est Railways* (in French). — It seems to me that we are getting rather away from the subject, if we are to keep strictly to the wording of the question.

I do think, however, that it is in fact necessary to adapt the operating methods to the use of the new possibilities technical progress is always putting at our disposal, and, generally speaking, as the previous speakers have made clear, this end has been attained.

It is certain, however, that from th technical point of view, further progre will have to be made. If, for exampl certain railways have run trains of up 12 vehicles driven by a single man, oth countries have not yet reached this stag

I think therefore that the progress sti to be made should be looked for at on and the same time in the characteristi of the railcar itself in order to adapt more and more to the requirements, an in the operating methods so as to get be ter and better utilisation, in meeting th same requirements, of the more an more improved engines which the evol tion of knowledge in this field wi give us.

I think, finally, that it would be well to adopt the wording of the summ ry as it stands with a slight modific tion. It is suggested we say that the fu ture of the railcar depends also on futu re improvements... « and on the adapt tion of the operating methods to the ra motor car. »

I suggest we say. « ... and on the ada tation of the railcar characteristics an methods of operation to the needs of th public » as, after all, our policy must b adapted to the requirements of the pu blic.

Mr. Matter, *Swiss Federal Railways* (French). — I do not wish to say an thing after all, as the suggestion I w going to make was similar to Mr. R nard's.

Mr. Day, *South African Railways an Harbours*. — The South African Ra ways are very interested in the metho that have been adopted in Europe to me the problem of obtaining efficient ra cars for service, but whilst being so i terested, it is appreciated that Sou African conditions are rather speci

e have gradients of 1 in 30, with cur-ures of 300 feet, and we should re-ire railcars to run on branch lines ere weights are limited. We have at esent approximately fifteen railcars in eration; they are not modern, being trol-operated, weighing about 14 tons, d are of limited capacity. We are, wever, of the opinion that we could e more railcars, and it is the intention the Administration to provide for a nsiderable number in the near future. In working out the cost of operation have been struck by the depreciation tor, and we thought it would be ad-able to get some information on this. is possible that many of the railcars ll not be running in ten years' time, d it is very probable that many of ese railcars will require the mechan-ns and transmissions being renewed fore ten years, and these are very im-rtant points, because the railcar must able to transport the passenger at rea-nable cost.

There is another point we should like formation on too. Certain Railways e using obsolete railway coaches in nning services which enable them to et the needs of the public, and we ould like some information regarding e costs of these services.

May I now state some of our difficul-s? The altitude goes up to 6 000 feet. e require a good power/weight ratio, rhaps 10 H.P. per ton, and we require reasonably large rail motor car within axle loading of 12 1/2 tons. It ap-ars to us that the railcar gives best re-lts where gradients are not severe. Our adients are severe — although I do not sh to infer that all our gradients are ere — perhaps 1 in 66 to 1 in 100, d if anyone is operating railcars under ese conditions we should like informa-n on it. We think that diesel cars will give the best results where the cost of fuel is most favourable.

May I touch also on the transmission problem? We are now running mixed trains, which are partly goods and partly passenger. This is very unsatisfactory, the goods train is heavily loaded, with one or two passenger cars on the ends, and the expense of stopping and starting the goods train is considerable, the time taken is long and you get very unsatisfactory operation from both goods and passenger points of view. We feel that we must separate the passenger traffic from the goods, and that the railcar will be the best means of doing this.

Regarding our long-distance traffic, very considerable distances have to be covered, usually requiring sleeping and dining accommodation, and this means that the application of the railcar will be limited to short-distance traffic.

Mr. Dumas (in French). — Taking the remarks made into account, I think it would in fact be a good thing to stress a little more definitely in Summary 1 the value of a mutual adaptation of the railcar and the operating methods, without going too far, however, so as to remain within the scope of our report, as Messrs. Renard and Matter pointed out.

I suggest the following wording for the last sentence of Summary 1 : « ... and especially on the mutual adaptation of the railcars and operating methods. »

Mr. Renard (in French). — Did you deliberately forget to take my suggestion into account, about saying that the main object was not the mutual adaptation of the railcar and operating methods or inversely, but the adaptation of both of them conjointly or simultaneously to the requirements of the public, which should be the dominating preoccupation.

Mr. Dumas (in French). — I did not add « to the needs of the public » on purpose, as we ourselves create these needs to some extent, and this lies somewhat outside the scope of our report.

The President (in German). — Does everyone agree to Summary 1 as amended by Mr. Dumas?

— *Adopted in its amended form.*

I shall be obliged if Mr. Dumas will read Summaries 2 and 3.

Mr. Dumas. — *Summary 2 :*

2. Railcar diesel engines can be divided into three classes :

(*a*) 600 to 1 800-H.P. engines, relatively heavy, but very economical as regards working and maintenance; such engines are used extensively in the United States of America;

(*b*) 300 to 600-H.P. engines weighing about 5 kgr. (11 lb.) per H.P., as adopted by most European Railways;

(*c*) 200 to 300-H.P. engines, amongst which the Czechoslovakian, German and French horizontal engines deserve special mention.

By the use of supercharging, which tends to extend, the weight/power ratio of engines can be reduced; improved behaviour of the motion and better dissipation of the lost heat units are also obtained.

Summary 3 :

3. Mechanical transmissions are quite satisfactory, as regards weight, cost and efficiency, up to 300 H.P. Mechanical transmissions for 450 and 500 H.P. are being tested in Italy and in France.

Electric transmissions are now fully perfected for all powers, and are preferred for services on mountain lines and for multiple-unit working.

Hydraulic transmissions have made definite progress in the course of the last two years, in respect of all powers and engine speeds, in Austria and Germany.

The President (in German). — Do anyone wish to raise any point in co nection with Summaries 2 and 3?

Mr. Renevey (in French). — I qu agree with Summaries 2 and 3 as a wh le, but I am not sure that it is not exaggeration to state that at the prese time there are 1 800-H.P. engines for ra cars.

Mr. Dumas (in French). — There a engines of this power in America.

Mr. Renevey (in French). — They a not railcars in my opinion.

I do not think we can call railca trains consisting of three diesel locon tives, each of 2 000 or 1 800 H.P., hauli 17 coaches.

The definition put forward just n by Mr. Lévy in this connection appe completely justified to me. The char teristic of railcars is that they can coupled together, and this is not the c with the 17 coaches of the Ameri train.

Mr. Dumas (in French). — The coach American trains can if requi be reduced to 12 coaches, for exam coupled up with other units.

Mr. Renevey (in French). — I q agree that the question of powerful gines and diesel-electric locomotives of great interest, and I am quite prep ed to suggest that these subjects be cluded in the agenda of a future C gress, but I do not think that there any 1 800-H.P. railcars properly speak

Mr. Dumas (in French). — I am so I cannot agree with Mr. Renevey in connection. When the principles which the 1 800-H.P. Winton engines w

uilt are considered, it is obvious that ney have nothing in common with the eavy oil engines like those used on die-el-electric locomotives.

These engines have been specially de-igned for railcars in America, and have nade it possible to increase the number f units in the *railcar* — I insist on the se of this word — from 3 to 4, 6, 12 nd finally 17 coaches. These engines re all designed on the principle of light-ess, with a gross weight/power ratio f the order of 5, 6 and 7 kgr. (11, 13.2 nd 14.4 lb.) per H.P., whereas the heavy ngines used on the diesel-electric loco-notives of the P.L.M., for example, ge-nerally weigh about 15 to 17 kgr. (33 to 7.5 lb.) per H.P.

Mr. Renevey (in French). — These rains make runs of 1 500 to 1 800 km. 930 to 1 120 miles), and in my opinion his is rather a case of diesel-electric ocomotives. The Americans are perhaps nore advanced than us, but I really do not see the difference.

Mr. Dumas (in French). — The run nay be 200 km. (125 miles) long if ne-essary. The fact that the American uns are longer does not mean using lifferent names.

Mr. Dreyfus, *Midi Railways, France* in French). — I think this difficulty ould easily be settled. The power of the ngine does not come into the question. f this powerful engine is fitted on a ehicle in which passengers are carried, hen it is a railcar or rail motor coach; f on the other hand this powerful en-ine is not fitted in a vehicle in which assengers are carried, then it is a loco-notive.

Mr. Dumas (in French). — This point has never been settled.

Mr. Dreyfus (in French). — If this is not so, the word « automotrice » (rail motor coach) has no meaning if it is used for vehicles which do not carry passengers.

Mr. Sakr. — I see no mention in the report of steam railcars, and Mr. Dumas mentions only diesel cars. In Egypt, we have steam railcars which are as good as the diesel railcars, and probably when we come to the question of costs there will be something said about steam railcars as well as diesel railcars.

Mr. Stroebe, *Reporter* (in German). — As regards the point raised by Mr. Rénevey, the Reichsbahn has adopted the point of view that the decisive factor is not the power of the engine, but the method of construction of the vehicle.

At the present time, for example, we have under construction, on the Reichsbahn, a 1 300-H.P. four-unit railcar and as its method of construction has certain well defined characteristics, we include the power vehicle in the rail motor coach class, for the following reasons :

1) it is intended to transport passengers and includes a compartment for carrying mails, and one for luggage and other goods;

2) it is coupled to three other vehicles of a related type and together with these forms a complete unit;

3) starting and propulsion are assured not only by this vehicle but also by the machinery carried in the other vehicles coupled to it.

In fact, whenever it is question of multiple units in which the power for starting and propulsion is distributed to

several vehicles, we call it a railcar; on the other hand in the case of a vehicle known as a « locomotive » there is no space for carrying passengers, luggage or mails, and the starting and propulsion depend entirely on the power vehicle.

Mr. Dumas (in French). — In brief, Mr. Stroebe says that the Reichsbahn is at present building a railcar of four vehicles, the first of which will be reserved exclusively for the engine and luggage, and the other three for passengers, and he considers that this is a « Triebwagen » (railcar) and not a locomotive. This unit has a 1 300-H.P. engine, so that it comes under heading *(a)* of Summary 2 : 600 to 1 800-H.P. engines.

Mr. Renevey (in French). — Agreed. This vehicle is under construction; now Mr. Dumas refers in his report to American vehicles which are known as locomotives in America.

Mr. Le Besnerais (in French). — Without going back to this controversial question, there is another point which I think of great interest : the progress made in transmissions.

The Special Reporter mentions mechanical, electrical and hydraulic transmissions. Could he give us some information on the efficiency of these different types of transmission and the number of defects which have arisen with them in service?

This question affects both the Operating and the Rolling Stock and Traction Departments. The efficiency is particularly interesting from the point of view of the Rolling Stock and Traction Department which wants to get the cheapest possible equipment, and defects affect the Operating in particular, which is very pleased to have an economical service, but is still more pleased when the service is worked without anything ever going wrong.

If Mr. Dumas cannot give us any information on this subject, we might perhaps get this information from the delegates representing the different Railways.

Mr. Dumas (in French). — I think the question of the efficiency of the different transmissions can be summed up as follows :

Mechanical transmissions : the efficiency has reached a high value, of the order of 90 %.

Electric transmissions : the efficiency is still low, about 78 %.

Hydraulic transmissions : the efficiency, which it was hoped would prove very high, is actually half-way between the two others.

Consequently more detailed information about hydraulic transmissions would be most interesting.

Mr. Stroebe (in German). — The Reichsbahn has latterly preferred to use the hydraulic transmission, which compared with electrical and mechanical transmissions, is characterised by its simplicity and reliability; the change over to the different speeds is easy, and any mistakes made in changing have no serious consequences.

The maintenance costs of the hydraulic transmission are also satisfactory; the purely hydraulic parts require no special maintenance; it must, however, be remembered that a hydraulic transmission also has a mechanical part, which is more fragile.

Compared with electric transmissions the hydraulic transmission has the advantage of weighing less and costing much less for the same power.

We have triple railcars in service, with a power of 2 × 600 h.p., one of which is equipped with electrical, and the other with hydraulic transmission; these units have, however, been in service too short a time for definitive conclusions to be formulated; these triplets are absolutely identical as regards the design of the vehicle properly speaking, but that equipped with hydraulic transmission weighs 10 tons less than the other.

These coaches are now in regular service, so that we will soon be able to make comparisons.

For multiple-unit working the hydraulic gear is quite suitable, and just as good as the electrical transmission.

It is also possible to easily couple up vehicles with electrical transmission and vehicles with hydraulic transmission.

Finally the hydraulic transmission has further possibilities as regards braking, the use of which is of particular importance on heavy gradients, even if they are only short ones, or on very long gradients, where the brakes are severely taxed; in such cases the brakes can be to some extent relieved or assisted and their action strengthened by means of additional braking devices of known design.

We have found that it is necessary to fit special equipment to make use of the hydraulic transmission for braking purposes; and this equipment has not yet been brought into being.

Mr. Le Besnerais (in French). — I am grateful to Mr. Stroebe for his very interesting explanation. My attention has been particularly attracted by the last point he mentioned, that of connecting the transmission with the braking. We have in fact been faced with a similar problem on the French Nord Railway, the problem of braking our very fast railcars.

We have considered a fourth method of transmission, not mentioned in the reports : this is pneumatic transmission. We consider designing a propeller railcar, this propeller being used both for propelling and stopping the vehicle.

This is a new type of transmission which has not yet been completed but is under construction, and I think it will be interesting to follow its evolution.

Mr. Leiner, *Czechoslovakian State Railways* (in French). — I would like to call the attention of the Meeting to the combined electro-mechanical transmission we use on our fast railcars.

Of all the types of transmission, mechanical, electric and hydraulic, we have obtained the best results from this combined type; it combines the advantages of the electrical transmission as regards starting, good acceleration, etc. with those of mechanical transmission, as regard efficiency at high speeds.

Railcars equipped with this transmission have already run many hundred thousand miles without coming up against any difficulties or requiring special maintenance.

Mr. Dumas (in French). — This type of transmission was specially mentioned in the third paragraph of our special report.

Mr. Nicolet (in French). — In the second paragraph of Summary 3 it says :

> Electric transmissions are now fully perfected for all powers, and are preferred for services on mountain lines and for multiple-unit working.

In order to take into account the results obtained recently when running

multiple units with mechanical transmissions in France, as well as the results expected from similar trials in Italy, I would like to make a slight change in the above paragraph as follows : « ... are preferred for multiple-unit working when heavy loads are to be hauled. »

Mr. Dumas (in French). — The P.L.M. delegate has stated that on his system the electric transmission has been adopted for hauling a trailer.

Electric transmission would therefore appear to be the most satisfactory for a simple trailer.

Mr. Nicolet (in French). — Coupling up two railcars with mechanical transmission as a multiple unit is now done very satisfactorily in France, both in the case of railcars with one engine and those with two. For experimental purposes, we have even gone as far as coupling up three railcars, each with two engines and two mechanical transmissions, with a single driver, which argues well for the future of these devices.

Mr. Dumas (in French). — That was mentioned in the special report.

Mr. Nicolet (in French). — The wording of the Summary might appear to imply that electric transmission is necessary in the case of multiple-unit working. I want this point to be insisted upon, seeing that the French railways have solved it satisfactorily.

Mr. Poncet, *French Est Railways* (in French). — I support Mr. Nicolet. It is understood that electric transmission is completely satisfactory for multiple-unit working, but mechanical transmission also gives a very good solution of the problem.

We use a great many coupled up rai cars with mechanical transmission o the Est Railway, we are very pleased wi the results, and we are far from consi ering adopting electric transmission the moment.

It would be enough to modifiy the fir paragraph of Summary 3 a little and sa for example :

« Mechanical transmissions are qui satisfactory... They are currently use for multiple-unit working. »

Mr. Van Schouwenburg, *Dutch Ea Indies Railways Company.* — I wish ask Mr. Stroebe if the mechanical part a hydraulic transmission does not bec me too complicated when it is also us for hydraulic braking, and if the mai enance costs do not become too high this case.

Mr. Stroebe (in German). — In rep to Mr. Van Schouwenburg's second poi the tests carried out so far have n made it possible to form a definite co clusion, but they seem to be satisfacto

As far as the other question is co cerned, I said just now that a special vice would appear to be necessary, wh we call « a brake converter »; such device is essential when much braki has to be done.

Tests made up to the present to the propulsion device by itself for br ing have proved that this method is adequate. It is hoped that the additi of the brake converter will not make hydraulic transmission unexpecte complicated, which would be contrary our object, which is simplification of driving equipment.

I want to raise another point in c nection with the second paragraph Summary 3; it says :

Electric transmissions are now fully p

ected for all powers, and are preferred for ervices on mountain lines and for multiple-nit working.

Now, electric transmissions are used n the Reichsbahn for very varied purposes. I think therefore that the wording of this paragraph might be made less ategorical.

We might perhaps say :

« Electrical transmissions for all powrs are generally preferred, especially for ervices on mountain lines and for mulple-unit working. »

Mr. Dumas (in French). — I think would certainly be a good plan to alter ummary 3 about the transmissions. The omplete text of Summary 3 would be :

« Mechanical transmissions are quite atisfactory, as regards weight, cost and fficiency, up to 300-h.p., and allow the oupling up of two or three vehicles. »

This is what Mr. Poncet had in mind ast now : working a few vehicles as mulple units, but this has nothing to do ith the working of some large trains, hich will be discussed later on.

Then comes the old text, as follows :

« Mechanical transmissions for 450 nd 500-h.p. are being tested in Italy and n France. »

Then :

« Electric transmissions are now ful- perfected for all powers, giving full atisfaction for services on mountain lies and for multiple-unit working. »

In view of the fact that there is a tenency to prefer mechanical transmisons in France, and hydraulic transissions on the Reichsbahn and in some her countries, it must not be stated at electric transmissions are always referred.

« Hydraulic transmissions have made definite progress in the course of the last two years, in respect of all powers and engine speeds, in Austria and Germany; they also allow of multiple-unit operation, even when coupled up to electric-transmission units. »

I think this agrees with the statements made by the delegates of the various Railways.

The President (in German). — Does the Meeting agree to the suggested alterations to Summary 3?

— *Adopted.*

— The Meeting also agreed to adopt the following altered wording for Summary 2 :

« 2. Railcar diesel engines can be divided into three classes :

(a) 600-h.p., and over, engines, relatively heavy, but very economical as regards working and maintenance; such engines are used extensively in the United States of America;

(b) 300 to 600-h.p. engines weighing about 5 kgr. (11 lb.) per h.p., as adopted by most European Railways;

(c) Up to 300-h.p. engines, amongst which the Czechoslovakian, German and French horizontal engines deserve special mention.

By the use of supercharging, which tends to extend, the weight/power ratio of engines can be reduced; improved behaviour of the motion and better dissipation of the lost heat units are also obtained. »

The President (in German). — Gentlemen, we have now finished examining points 1 to 3 of the Summaries; we will continue the discussions tomorrow morning at 9.30.

— The Meeting ended at 1.10 p.m.

Meeting held on June 3rd, 1937 (2nd and 3rd Sections meeting jointly).

PROFESSOR DR.-ING. W. WECHMANN IN THE CHAIR.

— The Meeting opened at 9.45 a.m.

The President (in German). — Gentlemen, we agreed Summaries 1, 2 and 3 yesterday, and today we will begin with Summary 4.

Mr. Dumas. — *Summary 4 :*

4. In order to reduce to a minimum the vertical movement of bogies, and to improve comfort, Railways are now using wheel tyres coned 1/40 and cylindrical tyres, multiple suspension gear and rubber shock absorbers. Such devices have not given rise to any difficulty, and their use can be recommended.

Some Administrations also use devices to damp out hunting movements and vertical vibrations, bogies (articulated or not) with six or eight wheels, loose wheels revolving on fixed axles, axleboxes without axleguards, etc. All these solutions have given them satisfaction.

I might add that it would be possible to preface this wording with a paragraph which would make it more explicit and make it clear that it is a question of comfort and proper spring gear.

I suggest therefore that we begin this summary with the sentence :

« All Administrations are adapting the suspension of their railcars to the permanent way, as it is at present constituted and maintained. »

The President (in German). — Does anyone wish to say anything about the modified form of Summary 4?

Mr. Lancrenon, *French Nord Railway* (in French). — The use of cylindrical tyres has been put off for a long tim because of the fear that the tyres woul wear too quickly.

On the Nord Railway we have used c lindrical tyres on fast triplets. We wer obliged to fit special steel tyres on thes cars in order to prevent excessive wea

We are now getting very good result the figures have already reached 10 mi lion axle-km. (6 200 000 axle-miles) a we only grind the tyres after 60 000 k (37 300 miles) on condition that the t res are made of very hard steel.

Do any of the Railways represent here take similar precautions to avo abnormal wear of the tyres when con 1 in 40 or even made cylindrical?

Mr. Van Schouwenburg (in French — I should like to know the quality the steel used?

Mr. Dumas (in French). — It is sp cial steel with a high tensile streng ranging about 100 kgr./mm² (63.5 En tons per sq. in.), known as « Moc » ste

Mr. Stroebe (in German). — T Reichsbahn uses a special steel with tensile strength of 80 to 92 kgr./m (50.8 to 58.4 Engl. tons per sq. in.).

After running 40 000 to 50 000 k (25 000 to 31 000 miles), the tyres ground, even if the amount of wear not enough to affect the riding.

A point in which we are particula interested is the choice of the tyre ma rial for vehicles intended to run at v high speeds, like our railcars timed speeds of 160 km. (100 miles) an ho

Up to the present, the experience avail-ble is not sufficient to formulate any efinite conclusions as to the resistance wear of such tyres at very high speeds.

The President (in German). — Does he Meeting agree to Summary 4 with he introductory paragraph proposed by r. Dumas?

— *Agreed.*

Mr. Renevey (in French). — Instead « tyres coned 1 in 40 *and* cylindrical res » I would like to say « tyres coned in 40 *or* cylindrical tyres ». This is erely a question of form.

Mr. Dumas. — Agreed.

The President (in German). — We ill go on to Summary 5.

Mr. Dumas. — *Summary 5 :*

5. Block brakes are most generally em-oyed at present; they are electrically con-olled in certain countries (U. S. A., Cze-oslovakia) and improved by the use of *ecelakrons* or self-regulators in proportion the running speed.

Amongst new brakes, the disk brake, the dy-current brake and the N.R. brake with uble shoes should be mentioned.

I would also like to point out that on ost railways there is a very marked lling off in the use of drum brakes, rum brakes with inside segments or rum brakes with outside blocks.

I did not think it was necessary to oint this out in the summaries.

The President (in German). — Does nyone wish to say anything?

Mr. Renevey (in French). — I would ke the wording of the end of the first ragraph to be slightly altered. Mention is made of « self-regulators in proportion to the running speed ». The word « in proportion » seems a little too definite to me.

In fact some block brakes act in proportion to the speed, while others give an additional pressure.

I suggest we say : « ... or regulators giving pressure on the blocks, varying with the speed. »

Mr. Dumas (in French). — I quite agree.

The President (in German). — Does anyone want to say anything else about Summary 5?

Mr. Stroebe (in German). — The German State Railways are using drum brakes on a large scale; these give very good results from the technical point of view. The only difficulty is the heat dissipation particularly in the case of long, heavy gradients. We are, however, trying to replace these brakes by disk brakes which have constructional advantages, especially lower weight and easier heat dissipation. Definite results in this connection are not yet available.

The President (in German). — Mr. Dumas will now read the amended text of this summary.

Mr. Dumas (in French). —

« 5. Block brakes are most generally employed at present; they are electrically controlled in certain countries (U.S.A., Czechoslovakia) and improved, in the case of high-speed working, by the use of Decelakrons or regulators giving pressure on the blocks, varying with the speed.

Amongst new brakes, the disk brake,

the eddy-current brake and the N. R. brake with double shoes, should be mentioned. »

The President (in German). — Does everyone agree to this?

— *Adopted.*

We will now examine *Summary 6.*

Mr. Dumas :

6. Sound-proofing and air-conditioning are particularly resorted to at present in order to increase comfort.

Steel-tyred vehicles — although they cannot claim the same comfort as pneumatic-tyred vehicles — can be improved by means of double partitions with air cushion; all openings should be carefully stopped up, and plates be lined with pulverised felting in order to avoid vibrations.

Air conditioning, and air cooling in summer (by means of ice or freon), are particularly appreciated in vehicles with fixed window lights.

As a commentary on this text, I might say that nowadays many railways have been led to adopt fixed lights, not in order to improve the air resistance coefficient of their railcars as was generally thought some years ago, but for greater comfort and to get rational air conditioning of their vehicles, as well as to shut out noise. This is rather a strange evolution of technical knowlege. An ill-founded argument in favour of fixed lights was put forward three or four years ago when we adopted them, but their use has shown the true reasons for adopting them.

I might add that this question of comfort : air conditioning and prevention of noise, affects all the stock, but it is perhaps more difficult to solve in the case of railcars than in that of other vehicles in view of the light construction required, which is an important factor of the railcar problem.

— *Mr.* PELLARIN, *President of the 3rd Section took the chair in place of Dr.* W. WECHMANN.

Mr. PELLARIN IN THE CHAIR.

The President (in French). — Does anyone want to say anything about Summary 6?

Mr. J. Lévy (in French). — The tendency to improve the comfort mentioned by Mr. Dumas, affects not only railcars but all stock in general, and all railway stock in particular.

There is another tendency — at least in France — to lighten railway vehicles, and at first sight it would seem that these two tendencies are contradictory.

It would be interesting to know if there is the same tendency in other countries — not to improve the comfort, as this is general — but towards lighter construction, and what progress has been made in this direction in the case of railcars.

In France considerable progress has been made in lightening stock recently, not only in the case of railcars but in the case of ordinary stock, on which the railcar seems to have had a very marked influence; for example it has been found possible to make the metal coaches 10 t (9.8 Engl. tons) lighter without reducing their strength.

The design of the body, consequently has very clearly been influenced by the development of the railcar.

The President (in French). — I must oint out that the point raised by Mr. évy raises a double issue : the lighten- ıg of railcars and the lightening of olling stock generally, inspired by the ormer.

As the latter subject is not on to day's genda, we must of necessity limit our- elves to the question of lightening rail- ars. Can anyone supply any informa- on in this connection?

Mr. Baticle, *Ministry of Public Works*, rance (in French). — The Special Re- orter has pointed out the marked ten- ency to fit fixed lights.

I want to know if the public has been onsulted about this in the different ountries represented at this Congress? is my impression that in many cases e public likes railcars, which do not ake any smoke, just because the wind- vs can then be opened, especially in mmer.

It would therefore be interesting to arn if public opinion on this matter as been investigated, seeing that the pu- ic, is after all, the most closely con- rned.

Mr. Dumas (in French). — I might ply that one of the greatest difficulties the railway engineer is precisely that has to act in all cases and organise erything without being in a position learn the wishes of the public.

The same question arises when new rvices are being introduced. The pu- ic does not say what it wants; only ter the services have been introduced ll it express its approval or otherwise.

As regards fixed lights, we as technic- experts think that when fixed lights e used in conjunction with air condi- ning, the comfort will be immensely improved from the point of view of ventilation and noise, and so the public will be satisfied.

The President (in French). — Does anyone else wish to say anything?

Mr. Poncet (in French). — In connection with paragraph 6 of the summaries, Mr. Lévy raised the question of lightening.

This question of lightening is obviously of topical interest for railcars. Its advantage is that it makes it possible to work a given service to a given timetable with an engine developing less power because the load to be hauled is less.

The result is that there is a saving on the one hand from the point of view of fuel consumption, and on the other from the point of view of maintenance of the engine, and finally also from the point of view of the amortisation charges for the engines.

The whole question is therefore to get weight reduction without increasing the maintenance costs, and on the other hand without loss of comfort. This is the main problem.

It appears that with the steels now available, it is possible to reduce the weight of the bodywork, and even the weight of parts in cast steel, without too great an increase in the amortisation charges nor in maintenance costs.

The most difficult question with the light railcar is that of comfort. It would be interesting to learn the opinions of the various countries in which trials of light railcars have been carried out.

I think that with the progress made in recent years, especially in the last few months, from the point of view of heat insulation and damping out noise, it should be possible to reduce the weight

of the coach and railcar bodies without any appreciable decrease in the comfort.

On the Est Railway we have just been able to get a weight reduction of about 25 % on suburban coaches — and from this point of view the question of coaches is rather like that of railcars; this weight reduction was obtained by using high-tensile weldable steels and light alloys. We have solved the problem of heat and sound insulation at the same time as that of protecting the plates by covering them with insulating material, such as sprayed asbestos (« flockage »).

Similar trials are being made with railcars. These are worth attention and any remarks that may be made on these points should be useful to railways who are going to make investigations of this kind.

Mr. Stroebe (in German). — According to the Reichsbahn, the questions of air conditioning and heating are some of the most important problems the railways have to solve at present.

It is difficult to equip railcars with automatic air conditioning, because of the weight of such equipment. However, it is impossible to ignore the question as railcars have to be run over very long distances, and consequently need perfect ventilation.

In the case of local trains, there is no need for these innovations.

As regards ventilation and heating, the Reichsbahn is now investigating solutions making it possible to combine the ventilation and heating plants as the weight can be considerably reduced thereby.

Some of the requirements of the public necessarily involve an increase in the weight, especially the size of the compartments and the arrangement of the seats.

It is possible, on the other hand, to obtain considerable weight reduction by using high-tensile steels and also by using welding; recent progress in the latter process has enabled us to get very considerable weight reduction.

As regards noise, we have found that rubber blocks have made a great difference.

At the present time we have a railcar in service with two horizontal engines fitted under the floor of the vehicle and insulated from the floor by rubber blocks; this arrangement has been completely satisfactory.

— Dr. W. WECHMANN *returned to preside over the Section.*

Mr. Nicolet (in French). — I want to mention the results obtained on the French Railways in connection with the ligthened body construction, and from this point of view I would like to point out that the question of fixed lights raised just now is also very closely connected with weight reduction, and makes for ease of construction and maintenance, as rust in certain parts under the windows is avoided.

However that may be, it is thanks to the new constructional methods evolved in the last few years that it is now possible to build railcar bodies 25 m. (82 ft.) and even 30 m. (98 1/2 ft.) long just as rigid and safe in use as the old types, though the weight has been considerably reduced.

The method consists essentially in making a tubular girder, including the sides and even the roof; this girder is then lined out inside and outside, as lightly as possible, with aluminium sheets, for example, which saves a lo

weight as these plates merely have to ll in the framework, which is the only ad-carrying part of the body.

This specially designed framework is uilt of good quality steel of high ten-le strength [usually 65 kgr. (41.3 Engl. ns per sq. in.) in France]. By using ese special steels, which are weldable, bent and welded plates or as tubes, nall girders with high moments of ertia can be made; the parts are as-mbled, in the case of thin plates, by ot welding, whereas arc welding is ed in the case of the larger parts.

We have even used cold-worked rust-ss steel (18 % chromium, 8 % nickel), hich has a strength of 105 kgr./mm² 6.7 Engl. tons per sq. in.), and, as it rustless, very thin plates can be used, 5 mm. (0.02 inch), for example.

This has enabled us to build very light t very strong bodies for railcars, ac-rding to the *Budd* (Philadelphia) pro-sses used in the construction of the nerican *Zephyr* trains, and even for ry light coaches intended to be worked ordinary steam trains.

These various new constructional me-ods make it possible to get a frame-ork which weighs only 4 to 7 tons for 25 m. (82 ft.) long body.

This result is particularly important om the point of view of weight reduc-n, and consequently from the point view of the railcar's working quali-s; in fact, the more the stock is light-ed, the more the acceleration is im-oved, and the greater the operating ssibilities. For example, local services th stops every 5 to 6 km. (3.1 to 3.7 les) can be run at an average speed 75 km. (46.6 miles) or even 80 km. 0 miles) an hour, instead of 60 km. 7.3 miles) an hour as at present.

Mr. Ogurek, *Polish State Railways* (in ench). — As regards noise, I would like to know how this is affected by the position of the engines, either on the bogies or in the body of the vehicle.

Mr. Dumas (in French). — In reply to Mr. Ogurek's question, with the progress made during the last few years in the use of rubber blocks, nowadays it is possible to damp out the noise of the engine equally easily whether it is fitted in the body or on the bogie.

Mr. Van Schouwenburg (in French). — Air conditioning is of particular interest in tropical countries where the air is very hot and damp.

Air conditioning can be effected in two ways : either without change of temperature by assuring a proper circulation of the air through the vehicle; or by lowering the temperature by means of ice.

In the first case, the feeling is somewhat like when the lights are dropped : the temperature remains the same, but there is good air circulation and the impression of humidity is reduced.

The second method gives a rather disagreeable feeling of cold, both on entering the coach and when leaving it after having sat in it for some time.

The first method is the more economical, as regards cost.

I want to know if any of the delegates here representing tropical or very hot countries can give us some information on this matter.

Mr. Sakr. — The Egyptian State Railways lately introduced in their diesel railcars a system of air conditioning with freon. The system was of American design, but we are not likely to extend its use, because it was so disagreeable to the passengers. The cost price of the installation was very high and the public could not bear the dampness

which you could feel whilst the apparatus was in operation. Of course, the temperature inside the car was very much reduced, and when you entered the car you felt the coolness of the atmosphere inside, but when you sat down you could not bear the dampness, and the passengers had to open the windows.

Mr. Dumas (in French). — Freon is now used on a large scale in the United States of America on most railways for air conditioning, which seems to prove that its use is satisfactory.

The President (in German). — Recently I had an opportunity to travel in the United States in both coaches and railcars and observe certain facts in connection with air conditioning. When the outside temperature was between 36 to 39° C. (96.8 to 102.2° F.), the inside of the vehicle was kept at a constant temperature of 23° C. (73.4° F.). The fresh air was blown in from above so fast that it gave the disagreeable feeling of a cold draught. I also had some experience of the system in which the air is passed over ice by means of fans.

I belive these devices are very popular in America, and have been adopted with very satisfactory results. Such equipment is very expensive, however, and in Germany where extremely hot days are very rare, they are not really necessary. They are chiefly useful in places where there are long heat waves.

Mr. Nicolet (in French). — In fact, I think this question of air conditioning depends above all on the climate of the country and the humidity of the air, which has to be increased or corrected.

There is also the question of the habits of the country. In America everyone lives in a draught. I myself have felt the same disagreeable feeling in an air-cooled coach as our President here; I seemed to be in a very uncomfortable draught at times.

The President (in German). — Are there any other delegates who want to raise any other points in connection with point 6 of the Summaries, especially about air conditioning? Time is getting on, and I think this same question is also on the agenda for all railway vehicles.

Does the Meeting agree with me in adopting this Summary?

Mr. Bloch, *Paris-Orléans Railway* (in French). — I would like to report that our railway quite agrees with the conclusions arrived at.

We think that on fairly short runs, it is quite unnecessary to have air conditioning plant which often absorbs a lot of power; it is better to make use of ice which only needs a 1/4 H.P. fan. With 300 kgr. (660 lb.) of ice in a coach or railcar, it is possible to make a six hour run before the ice is completely melted.

We think this is sufficient, and the trials we have made on four coaches now in service have led us to conclude that under these conditions the inside temperature can be reduced 6° C. below that of the outside air.

Mr. Dumas (in French). — I will read the new wording which might be adopted to take all the statements made into account :

6. Sound-proofing and air-conditioning are particularly resorted to at present in order to increase comfort.

Steel-tyred vehicles — although they cannot claim the same comfort as pneumatic-tyred vehicles — can be improved from the point of view of noise, by means of double partitions with air cushion, pulverised felting on the plates

nd the careful stopping up of all open-gs.

Air conditioning, and air cooling in mmer, are particularly appreciated in hicles with fixed window lights. »

This new text condenses all the recom-endations of the old summary to close l openings and carefully line them out, ithout specifying that this applies to l railcars of every type.

Mr. Renevey (in French). — I would ke to point out that lining out the pla-s with felt is not the only possible me-od.

I would like to add « ... or other pro-sses. »

Mr. Dumas (in French). — I agree th the wording « ... particularly by the e of double partitions with air cushion, lverised felting, and the careful stopp-g up of all openings. »

Mr. Van Schouwenburg. — In the ird paragraph I suggest we say : « Air nditioning, with our without air cool-g, is particularly appreciated... »

The President (in German). — Let us y : « Air conditioning, with or with-t air cooling in Summer, is particular-appreciated... »

Mr. Stroebe (in German). — It seems visable to include in the second para-aph some mention of the rubber inter-ings which have given goods results the Reichsbahn from the point of ew of noise reduction.

Mr. Dumas (in French). — Exactly. ubber is a very effective preventive of ration, just as it says in paragraph 4, d of noise; we will mention this by ding to paragraph 6 : « ... particularly by the use of double partitions with air cushion, pulverised felting, *rubber*, and the careful stopping up of all openings ».

The President (in German). — Does everyone agree?

— *Summary 6 was adopted with these modifications.*

We will now go on to Summary 7.

Mr. Dumas. — *Summary 7 :*

7. Maintenance costs and amortization charges are the biggest items in the cost price.

The first cost of American railcars is high, but their maintenance costs are reduced to a minimum; in Europe, the desire for lightness has generally led to cheaper construction, which entails higher maintenance costs.

It would be desirable that the Railways agree to calculate in a uniform way the coefficient of use of their railcars and their cost price.

I do not know if the recommendation in this last paragraph can be adopted in this form.

Perhaps the following wording could be adopted : « The Congress expresses the wish that the Railways...»

Mr. Poncet (in French). — I have two little remarks to make about this summary.

In the first paragraph : « Maintenance costs and amortization charges are the biggest items in the cost price », I want to add « of railcars with diesel engines »; it does not apply to petrol railcars which, though few in number, are still used.

In the case of the second paragraph, I wonder if it is desirable to keep this wording, which from the point of view of the summaries gives us no definite data and may even be disputed as regards the second part : « ... the desire for

lightness has generally led to cheaper construction, which entails higher maintenance costs ». I do not know if it is very accurate to say that weight reduction has always led to increased cost price.

It seems to me we might say :

« The quest for lightness is desirable from the point of view of the possibilities of the railcars and the reduction of traction costs, but it must be pursued simultaneously with the search for comfort, care being taken to reduce to a minimum the increases in first cost and maintenance costs ».

As for the third paragraph, I agree with the suggested wording. It might however be a good thing to explain exactly what is meant by « coefficient of use ».

Mr. Dumas (in French). — In the case of the third paragraph, I think we are all in agreement in a general way, but we might be more definite about the detailed method of calculation. I am afraid, however, that it is difficult to go into further details.

Mr. Poncet (in French). — Different interpretations of the way statistics should be got out have been reported.

By « coefficient of use » of railcars, the French Railways mean the ratio of the mileage to the stock; certain foreign railways, when speaking of the railcar mileage, mean the mileage per railcar in service, not the whole stock of railcars.

Mr. Dumas (in French). — In my opinion we are not competent to include in our summaries a definition of the coefficient of use of railcars.

On the other hand, I agree with Mr. Poncet that it should be made clear in the first paragraph that it is in the case of diesel-engined railcars that the maintenance costs and amortization charges are the biggest items.

In the case of the second paragraph, I will reserve my opinion on the modified text suggested by Mr. Poncet until the matter has been discussed by the Meeting.

Mr. Sakr. — The expression « coefficient of use » is rather vague, and more definition is needed. On the Egyptian State Railways a special account is kept with regard to railcars, which gives all information.

Mr. Dumas (in French). — The railways must agree about a definition. The Congress can only put forward summaries.

Mr. Sakr. — With regard to the first paragraph. Yesterday did not give any reference to steam railcars, and whilst talking about costs it may be of interest to mention some of our experiences in Egypt with steam railcars as well as with diesel railcars.

In 1935, the Egyptian State Railways bought ten steam railcars and ten diesel railcars of about 220 H.P. each unit. The seating capacity of the steam railcars is 60 % more and the cost price 20 % less than of the diesel cars. These cars were put together on suburban and local services of passenger trains with a maximum speed of 85 km. (52.8 miles) an hour. The steam railcars surpassed the diesel railcars in these services. The working expenses of the steam railcars were 10 % less than for the diesel cars. The steam railcars failed once every 250 000 km. (155 000 miles) run, whilst the diesel cars failed once every 20 000 km. (12 500 miles) run.

The diesel cars may be ideal for long

non-stop services, also for localities where water is scarce or unsuitable for raising steam, but for short distances I can rather say, in the light of our experience, that the steam railcars are much more economical on the Egyptian State Railways.

Mr. Dumas (in French). — The information given by Mr. Sakr about Egypt is very interesting, but it does not enable us to draw any conclusions in favour of the steam railcar, seeing that other railways have obtained diametrically opposite results, or at least very different results from those just reported.

The Belgian National Railways Company gave us very detailed information about the cost price of steam railcars compared with diesel railcars.

The Belgian Railways are particularly well qualified to express their opinion in this connection as each of their Sentinel steam railcars has run on the average 574 000 km. (356 670 miles) since being put into service, which means a total of 1 720 000 km. (1 069 000 miles) or thereabouts in five years.

This Company also has some diesel railcars, put into service at the same time, which have an average mileage of 530 000 km. (329 330 miles) to their credit; they have been good enough to give us details of the cost per kilometre, and this proves that neither method is definitely cheaper than the other.

On the other hand the Belgian Railways appended to the cost of the Sentinel steam railcars and the Maybach diesel railcars, the cost of railcars of the pattern used in Egypt, but the latter are higher than either the Sentinel or the Maybach, so that I do not want to pronounce in favour of either type.

Mr. Jr. Lévy (in French). — We know that steam railcars are very little used in Europe in general and France in particular. It is also certain that in other countries they seem to give very good results.

It is very difficult to compare two methods from this particular point of view. In making such a comparison it is necessary to take into account the experience of the builder and the practical experience obtained from the driving and maintenance points of view.

At the beginning, the diesel railcars had very high maintenance costs and there were many failures. When both the builders and the railways had had greater experience, these costs became much less, and there were far fewer failures.

The 250 or 300-h.p. Renault engines used in France two years ago, for example, had to be sent back to the builder for a thorough overhaul after every 60 000 km. (37 300 miles). At the present time they only go back after 120 000 to 150 000 km. (74 600 to 93 000 miles). This shows how much progress has been made in this case.

As for choosing between the steam railcar and the diesel railcar, what is to be hoped for is that the partisans of both sides will push on, and the competition which existed at one time be renewed, as this alone makes for true progress.

As for the conclusion suggested by Mr. Poncet, I wish to say that it is not certain that weight reduction involves higher maintenance costs. It is even probable — as I have just said about Renault engines, for example — that with more experience the maintenance costs will be reduced whilst obtaining considerable weight reduction.

For example, take the engine; some years ago the only satisfactory solution

from the point of view of cost seemed to be the engine with a low speed of rotation, 600 to 800 r.p.m., but we now get just as satisfactory results with 1 500-r.p.m. engines, and it is to be hoped than in a few years engines revolving at even higer speeds and weighing much less will be equally satisfactory.

It is also possible to build lighter bodies by using the new methods made possible by improvements in metallurgy and metal construction, these bodies being just as strong.

I think it is a mistake, therefore, to contrast weight reduction and the ultimate cost with one another.

The President (in German). — Does anyone else wish to speak?

Mr. Dugas, *Paris-Orléans Railways* (in French). — I also think we might alter the wording of the second paragraph of Summary 7.

Mr. Dumas (in French). — The second paragraph has been cancelled at Mr. Poncet's request; a new text will be submitted.

Mr. Dugas (in French). — I wish to call attention to the fact that in this paragraph the distinction to be made between the railcar with a high-speed engine and that with a low-speed engine is not made clear. This is one of the fundamental points of the summaries.

Mr. Dumas (in French). — What do you suggest?

Mr. Dugas (in French). — Make the second paragraph more precise by explaining what type of railcar is in question. The word « American » is not sufficiently explicit.

Mr. Sakr. — Our experience of stea railcars on the Egyptian Railways dat to 1927, when we had Clayton, and lat Birmingham and other steam railcars s milar to those on the Belgian Railway Owing to the tendency of all railways t acquire diesel cars we had to follow, an we bought diesel cars from a very goo firm.

In order to give diesel cars a fair tria we left their maintenance in the hand of the builders themselves, with thei own men and their own engineers s that the cost of maintenance would b reduced, or at least not increased, b being left in the hands of inexperience men.

After these trials we came to the con clusion that the steam railcar is muc better for suburban trains.

We do not condemn the diesel car, bu we do say that it is better only for no stop runs.

Mr. Munck, *Vice-President.* — In di cussing the way in which diesel cars a used one should speak of quick runni and slow running engines.

We are now using cars having two e gines of 250 H.P. each, 500 H.P. in a and there is a saving in weight a space. Experiments have been very tisfactory.

You might ask why we are using tw engines; it was — at the start — for fety, but the present idea of using th is to save length of the engine room give more passenger space, which is v important, the limit of car length be 22 metres to meet the needs of the sh and ferries.

Mr. Dumas (in French). — I th Summary 7 may be worded as follow

1st paragraph :

« 7. Maintenance costs and amort

ion charges are the biggest items in the ost price of diesel-engined cars.

2nd paragraph :

« Several Administrations are seeking bove all a reduction of maintenance osts by using preferably relatively low-peed engines of heavy construction.

« Other Administrations desire maxi-num lightness in order to increase the ossibilities of the railcar and to reduce he running cost; they consider that the rogress made in the matter of lighten-ng will allow them to arrive at a rea-onable maintenance cost.

3rd paragraph :

« The Congress considers it desirable hat the Railways agree to calculate in a niform way the coefficient of use of heir railcars and their cost price. »

(This recommendation was ultimately dded to Summary 9.)

The President (in German). — Does veryone agree to these words?

— Summary 7 was adopted in this mo-ified form.

Mr. Dumas. — *Summary 8 :*

8. Most Administrations tend to increase ie capacity of their railcars, so as to be ble to substitute them for steam trains on n increasing scale. The question is to re-ain very much below the cost per mile : a train.

As regards general design, various solu-ons are being resorted to : observation rail-rs, twin railcars or single railcars coupled gether, railcars hauling trailers, multiple-nits of 3 to 17 vehicles.

Mr. Barata (in French). — As I un-erstand it, the first part of Summary 8 ates that generally we limit ourselves to comparing the cost per kilometre of the steam train with that of the railcar.

In my opinion, it is not sufficient to base our conclusions solely upon this comparative calculation. Seeing that railcars are intended to attract the public to the railway, and, as was stated at yesterday's meeting, for the good of the public the use of railcars implies services at very frequent intervals, I think we ought to stress the general operating results, or in other words compare the receipts and expenses.

If my proposals merit the attention of the Meeting, I would be much obliged if Mr. Dumas would introduce in his summary the idea of the operating coefficient.

Mr. Legrand, *French Local Organising Commission* (in French). — The remark I wanted to made was similar to Mr. Barata's.

My suggestion was that we should suppress the second sentence of the first paragraph : « The question is to remain very much below the cost per mile of a train ».

In fact, I think that if the railways are going to replace their steam trains by railcars on an increasing scale, it is because of all the advantages they find in their use : advantages as regards speed, acceleration, braking, etc. The cost per kilometre of the train is in my opinion only one aspect of the question, not the whole of the question by any means.

Mr. Jourdain, *Chemins de fer secondaires du Nord-Est* (in French). — I want to say something in this connection. I think that the Special Reporter very rightly introduced in this conclusion the question of the cost price. The question of the railcar is being examined from a general point of view, but there are

two different ways of using railcars : on the secondary lines of a large system, and for long-distance transport.

I think the latter is the one chiefly under consideration.

On the other hand when a railcar is used on the secondary lines of a large system, the main desideratum is economy, and consequently lowering the cost per kilometre.

I regret missing yesterday's meeting, as I would have liked to ask the Special Reporter if in Summary 2 the figure quoted of 200 H.P. in his opinion can be taken as the absolute limit, because we operate the secondary lines of main-line railways and we use railcars of only 125 to 130 H.P., which are also used by the main-line railways; now the cost of these railcars is extremely satisfactory and comes to less than 2 francs per kilometre per coach, i.e. less than 40 gold-centimes.

I think we ought to try and reduce the operating costs of these secondary lines as much as possible, and consequently the idea of the cost mentioned by the Special Reporter should not be deleted.

Mr. Cardon, *Paris-Orléans Railways* (in French). — As regards the beginning of Summary 8, I think that if most railways have increased the capacity of their railcars, this was done not only « so as to able to substitute them for steam trains on an increasing scale », but to meet the operating requirements and satisfy public requirements as economically as possible.

I certainly think we should retain this idea of economy; it should be referred to, however, not in connection with the cost per kilometre but in connection with the balance sheet.

In fact what matters is the final balance sheet which takes into account no only the cost per kilometre of the railcar but the sum total of the expenditure du to using railcars and the variation in th receipts resulting therefrom.

Increasing the capacity of railcars is in short, a way of improving the balance sheet of the railcar services, while meeting the operating requirements and th wishes of the public.

I think the first paragraph of Summary 8 should be modified so as to tak this into account.

As regards the second paragraph o Summary 8, I suggest suppressing th introduction : « As regards general de sign... »

In addition I would like a more pre cise definition of « autorails panorami ques » (observation railcars), which im plies that the engine is fitted under th floor.

Mr. Goursat, *French Nord Railway* (i French). — The subject dealt with i the reports is the evolution of the rai car from the constructional point o view, so I am wondering, just as in th case of one of the subjects discusse yesterday, if we are not going outsid the limits of the question in investiga ing the much wider problem raised ju now by certain Delegates, namely the e fects of using railcars on the operatin results of a line or railway.

This is a very interesting and topic problem, but it deserves thorough inve tigation as a problem in itself.

The Special Reporter certainly did n intend to touch upon a problem of th kind, since in Summary 8 what he r ports is a tendency.

I think we should not go outside th scope of the question dealt with in th report, and I suggest the following wor

ing for the first paragraph of summary 8, which I think could be admitted and does not raise such wide issues :

« Most Administrations, to be able to replace steam train services by railcar services, are led to increase the capacity of their railcars.

In order to solve problems of this kind, railcars, the cost price of which, when their capacity is taken into account, is definitely lower than that of the steam train, must be available. »

This states that the cost price of the railcar, lower than that of the steam train, is a necessary condition, but should not of itself be taken as sufficient, as this cannot be affirmed before a much more detailed investigation into the matter has been made.

Mr. Dumas (in French). — I agree with Mr. Goursat's suggestion which allows us to touch upon the subject without going into details about the balance sheet.

For the first paragraph, I approve of Mr. Goursat's text in principle.

In the second paragraph I suggest we say :

« Various solutions are resorted to : observation railcars, twin railcars, or single railcars coupled together, trailers, multiple units (rames multiples).

I am keeping the expression « rames multiples » (multiple units), because these are used in America.

Mr. Cardon (in French). — All the same it seems to me that we cannot remain content with saying that railcars are destined to replace steam trains, and that only the price per kilometre has to be taken into account. Moreover, when I asked that the latter should be replaced by the idea of the balance sheet, I had no intention of defining the way it should be got out, which would be much too vast a subject. I quite agree that we should limit ourselves to the problem of construction without attempting to explore this unduly extensive field. I merely intended to explain that increasing the capacity of railcars is one way of improving the balance sheet for railcar services.

Mr. Stroebe (in German). — The definition of « voiture panoramique » (observation railcar) as used by Mr. Dumas does not agree with the opinion of the Reichsbahn, which takes this word to mean special 60 seater vehicles, which will not be built in any large numbers.

Mr. Dumas (in French). — Apart from the Reichsbahn, in England for example, twenty 200-h.p. railcars have been built all of which are observation railcars

The new wording submitted to the Meeting to vote on is as follows :

« Most Administrations, in order to improve their operating costs and to give satisfaction to the public, tend to replace their train services by railcar services and, in this connection, to increase more and more the capacity of the railcars.

« In order to solve these problems, railcars the cost price of which, when their carrying capacity is taken into account, remains definitely below that of the steam trains, must be available.

« Various solutions are resorted to : railcars with engines placed underneath the floor, twin railcars, or single railcars coupled together, railcars hauling trailers, and multiple units. »

Mr. Cardon (in French). — Since the first paragraph introduces the idea of the improved operating costs, it does not

seem necessary to say that the cost per kilometre per railcar should be kept below that of the steam train, as what we are really endeavouring to get is the minimum cost per kilometre and this comes into the improvement of the balance sheet.

Mr. Dumas (in French). — I think this Summary cannot be disputed. It might be extended, paraphrases might be found for the cost of railcars, but the text I have just put before the Meeting is a statement of fact.

Mr. Cardon (in French). — Why not say that it is one of the ways of lowering the cost per kilometre to the minimum or of improving the balance sheet.

Mr. Dumas (in French). — I said « to improve the operating costs ».

Mr. Cardon (in French). — As regards increasing the capacity of railcars, the first paragraph mentions the two essential factors when it speaks of the operating costs and the satisfaction of the public.

As for the economic aspect of the question, the second paragraph seems superfluous to me, and moreover I cannot see why the comparison is only between railcars on the one hand and steam trains on the other.

Mr. Dumas (in French). — I agree that we might delete the word « steam » and just say « train ».

Mr. Nicolet (in French). — Supposing one day you have a railcar which costs as much as some steam or other train, and you can charge higher rates on account of the much higher average speed, or just because this kind of service is the fashion?

Mr. Cardon (in French). — We haven't just got to make a simple comparison between the cost per kilometre, even if we are dealing with trains in general instead of just steam trains as previously; nor must we limit ourselves to the subsitution of railcars for trains only.

In the case of the former, the expression « improve their operating costs » introduced in the first paragraph is sufficient in itself; it takes into account on the one hand, the receipts earned, on the other the reduction or increase of the expenditure, because there are some railcar services which lead to increased costs.

In connection with my second remark, I want to point out that in certain cases it is possible to work services by railcars which would be impossible with steam, and in this case I do not see how any comparison can be made between the cost per kilometre for the railcar and the train; for this reason at least let us say nothing further about lowering the cost per kilometre below that of the steam train replaced by a railcar.

Mr. Dumas (in French). — I cannot see why you are not pleased with the wording.

Mr. Cardon (in French). — Mention is made of lowering the cost below that of a steam train, the words « replaced by the railcar » being understood at the end of the first paragraph.

Mr. Dumas (in French). — It says « ... remains definitely below... ».

Mr. Cardon (in French). — My objection is not a matter of words. I insist in particular on the fact that there are some railcar services which cannot be compared with a similar steam train service. I want the second paragraph at least to be deleted, referring to the comparison with steam trains.

Mr. Dumas (in French). — It would then read :

« 8. Most Administrations, in order to improve their operating costs, and to give satisfaction to the public, tend to replace their train services by railcar services and, in this connection, to increase more and more the capacity of the railcars.

« As regards general design, various solutions are being resorted to : railcars with engines placed underneath the floor, twin-railcars, or single railcars coupled together, railcars hauling trailers and multiple units ».

Does everyone agree?

Mr. J. Lévy (in French). — I would not have mentioned the replacement of trains.

Mr. Dumas (in French). — It says « most », which implies it is not a general rule.

Mr. Matter (in German). — I also am of the opinion that the cost per kilometre should not be taken as the basis for comparison, seeing that generally speaking railcars are often called upon to work other than train services.

We have noted the case of a train which has had to be replaced by several railcar services. On the other hand, trains do not merely carry passengers, but also mails, luggage, parcels, livestock and other goods.

That is why I think it a mistake to compare units of different magnitudes, and I am of the opinion that we should vote for the suggested wording of the first paragraph which mentioned the operating costs.

When discussing Question VII, we will find that the same problems will crop up, moreover.

The President (in German). — Does the Meeting agree that the text of Summary 8 just submitted by Mr. Dumas be adopted?

— *Adopted.*

Mr. Dumas (in French). — We will go on to Summary 9; I will read the text which has been slightly altered.

9. The Congress considers it desirable for the Railway Administrations to adopt a common test method for ascertaining the characteristic constants of their railcars. On the other hand, the nominal power of engines should be given the same definition in all countries.

This is an extremely important question, but it is outside the scope of these discussions. Consequently all we can do is to make a recommendation on the subject.

Mr. Nicolet (in French). — I agree with this, and I see that we have gone through all the Summaries.

I am wondering, however, if it would not be possible to include in the summaries a few words about the importance of proper maintenance, the maintenance methods, the specialist staff that must be employed, the specially adapted tools required, the shops needed, and the collaboration with the suppliers, necessary to perfect the engines and transmissions in order to get the best results.

Certain railways which have only recently introduced railcars, or are about to do so, could in this way usefully be warned what to expect, especially as regards specialist staff and very meticulous maintenance methods.

Mr. Dumas (in French). — I could not be otherwise than in agreement with Mr. Nicolet, but I do not see how we

could add a Summary about these matters.

The President (in German). — Does everyone agree about the wording of Summary 9?

— *Summary 9 was adopted; it was also decided to add the recommendation included in the original text of Summary 7, so that the complete text of Summary 9 is as follows :*

« 9. The Congress considers it desirable for the Railway Administrations to adopt a common test method for ascertaining the characteristic constants of their railcars. On the other hand, the nominal power of internal combustion engines should also be given the same definition in all countries.

« The Congress considers it desirable that the Railways agree to calculate in a uniform way the coefficient of use of their railcars and their cost price. »

— The Meeting ended at 1 p. m.

DISCUSSION AT THE PLENARY MEETING

held on the 7th June, 1937.

MR. HENRY-GREARD, VICE-PRESIDENT, IN THE CHAIR.
GENERAL SECRETARIES : MESSRS. P. GHILAIN, DE BOYSSON AND CAMBOURNAC.
ASSISTANT GENERAL SECRETARIES : SIR H. NIGEL GRESLEY AND DR. TH. KITTEL.

The President. — Gentlemen, we are now going to examine the Summaries for Subject IV.

Mr. Ghilain, *General Secretary.* — The text of the Summaries for Subject IV was published in No. 3 of the *Daily Journal of the Session.*

Mr. Ghilain read Summary 1 :

1. Satisfactory technical solutions have been found in the course of the last two or three years to the speed, acceleration, braking and safety problems.

The future of the railcar now depends on the solutions that will be adopted as regards comfort, economical maintenance and capacity. This future also depends on future improvements of the track (curves, superelevation, elimination of rail joints or reduction of their number), and especially on the mutual adaptation of the rail motor car and the operating methods.

The President. — Any remarks?

Mr. Matter, *Swiss Federal Railways* (in French). — When this was discussed by the Section, it was suggested that the second paragraph of this summary be completed by the words : « and the traffic requirements » I want to remind you of this proposal and suggest the end of this paragraph be worded as follows : ... and especially on the mutual adaptation of the rail motor car, operating methods and traffic requirements. »

The President (in French). — Do the Delegates of the 1st and 3rd Sections agree to this suggestion?

— As no objection was raised, Summary 1 was adopted with this amendment.

Mr. Ghilain then read Summaries 2 to 9 in turn.

— No objections were raised during this.

The President. — The Summaries for Question IV may therefore be taken as approved.

Summaries.

« 1. Satisfactory technical solutions « have been found in the course of the « last two or three years to the speed, « acceleration, braking and safety pro- « blems.

« The future of the railcar now de- « pends on the solutions that will be « adopted as regards comfort, economi- « cal maintenance and capacity. This fu- « ture also depends on future improve- « ments of the track (curves, superele- « vation, elimination of rail joints or « reduction of their number), and espe- « cially on the mutual adaptation of « the rail motor car, operating methods, « and traffic requirements.

« 2. Railcar diesel engines can be di-
« vided into three classes :

« *(a)* 600-H.P., and over, engines, rela-
« tively heavy, but very economical as
« regards working and maintenance ;
« such engines are used extensively in
« the United States of America;

« *(b)* 300 to 600-H.P. engines weighing
« about 5 kgr. (11 lb.) per H.P., as adopt-
« ed by most European Railways;

« *(c)* Up to 300-H.P. engines, amongst
« which the Czechoslovakian, German
« and French horizontal engines deserve
« special mention.

« By the use of supercharging, which
« tends to extend, the weight/power ra-
« tio of engines can be reduced; improv-
« ed behaviour of the motion and better
« dissipation of the lost heat units are
« also obtained.

« 3. Mechanical transmissions are
« quite satisfactory, as regards weight,
« cost and efficiency, up to 300-H.P., and
« allow the coupling up of two or three
« vehicles. Mechanical transmissions for
« 450 and 500-H.P. are being tested in
« Italy and in France.

« Electrical transmissions are now
« fully perfected for all powers, giving
« full satisfaction for services on moun-
« tain lines and for multiple-unit work-
« ing.

« Hydraulic transmissions have made
« definite progress in the course of the
« last two years, in respect of all powers
« and engine speeds, in Austria and Ger-
« many; they also allow of multiple-unit
« operation, even when coupled up to
« electrical-transmission units.

« 4. All Administrations are adapting
« the suspension of their railcars to the
« permanent way, as it is at present
« constituted and maintained.

« In order to reduce to a minimum
« the vertical movement of bogies, and
« to improve comfort, Railways are now
« using wheel tyres coned 1/40 or cylin-
« drical tyres, multiple suspension gear
« and rubber shock absorbers. Such de-
« vices have not given rise to any diffi-
« culty, and their use can be recom-
« mended.

« Some Administrations also use de-
« vices to damp out hunting movements
« and vertical vibrations, bogies (arti-
« culated or not) with six or eight
« wheels, loose wheels revolving on fixed
« axles, axleboxes without axleguards,
« etc. All these solutions have given
« them satisfaction.

« 5. Block brakes are most generally
« employed at present; they are electri-
« cally controlled in certains countries
« (U. S. A., Czechoslovakia) and improv-
« ed, in the case of high-speed working,
« by the use of Decelakrons or regulators
« giving pressure on the blocks, varying
« with the speed.

« Amongst new brakes, the disk brake,
« the eddy-current brake and the N. R.
« brake with double shoes, should be
« mentioned.

« 6. Sound-proofing and air-condi-
« tioning are particularly resorted to at
« present in order to increase comfort.

« Steel-tyred vehicles — although they
« cannot claim the same comfort as
« pneumatic-tyred vehicles can be im-
« proved from the point of view of noise,
« particularly by the use of double par-
« titions with air cushion, pulverised
« felting, rubber, and the careful stop-
« ping up of all openings.

« Air conditioning, with or without

« air cooling in summer, is particularly appreciated in vehicles with fixed window lights.

« 7. Maintenance costs and amortization charges are the biggest items in the cost price of diesel-engined cars.

« Several Administrations are seeking above all a reduction of maintenance costs by using preferably relatively low-speed engines of heavy construction.

« Other Administrations desire maximum lightness in order to increase the possibilities of the railcar and to reduce the running cost; they consider that the progress made in the matter of lightening will allow them to arrive at a reasonable maintenance cost.

« 8. Most Administrations, in order to improve their operating costs, and to give satisfaction to the public, tend to replace their train services by railcar services and, in this connection, to increase more and more the capacity of the railcars.

« As regards general design, various solutions are being resorted to : railcars with engines placed underneath the floor, twin-railcars, or single railcars coupled together, railcars hauling trailers, and multiple units.

« 9. The Congress considers it desirable for the Railway Administrations to adopt a common test method for ascertaining the characteristic constants of their railcars. On the other hand, the nominal power of internal combustion engines should also be given the same definition in all countries. »

« The Congress considers it desirable that the Railways agree to calculate in a uniform way the coefficient of use of their railcars and their cost price ».

[621. 13]

QUESTION V.

Recent improvements in steam locomotives

of the usual type and tests of new designs (high-pressure reciprocating locomotives and turbine locomotives) as regards construction, quality of materials used, efficiency, working conditions, maintenance and financial results.

Testing locomotives

at locomotive experimental stations, and in service with dynamometer cars and brake locomotives.

Preliminary documents.

Report (Great Britain, Dominions and Colonies, America, China and Japan), by Sir H. Nigel GRESLEY. (See *Bulletin*, December 1936, p. 1291, or special issue No. 9.)

Report (Germany, Austria, Belgium and Colony, Denmark, Finland, France and Colonies, Hungary, Luxemburg, Norway, Netherlands and Colonies, Poland, Sweden and Switzerland) by Messrs. PARMANTIER and DUGAS. (See *Bulletin*, April 1937, p. 895, or special issue No. 27.)

Report (Italy, Spain, Portugal and Colonies, Czechoslovakia, Jugoslavia, Bulgaria, Rumania, Greece, Turkey and Egypt), by Signor MASCINI. (See *Bulletin*, April 1937, p. 1041, or special issue No. 28.)

Special Reporter : Sir H. Nigel GRESLEY. (See *Bulletin*, June 1937, p. 1521.)

DISCUSSION BY THE SECTION.

Meeting held on the 4th June, 1937.

PRESIDENT : PROF. DR.-ING. WECHMANN.

— The Meeting was opened at 9.30 a.m.

The President (in German). — Before we begin the discussions on Question V, I want the Meeting to know that Sir Henry FOWLER, formerly Chief Mechanical Engineer of the London, Midland and Scottish Railway and President of one of the British Ministry of Transport Commissions, who has always devoted himself to the work of the Congress Association, has expressed his great regret at being unable to attend this Session owing to ill health. I am sure that I am expressing the unanimous feelings of the Meeting in saying that we regret his absence just as much as he does, seeing that it deprives us of his valued collabor-

ation, and prevents the Congress from profiting by his accumulated knowledge and lengthy experience. We all hope he will soon be better. *(Agreed.)*

I will now call upon Sir Nigel Gresley, the Special Reporter.

Sir Nigel Gresley, *Special Reporter*. — I have the honour to present to you the reports which have been in circulation since the latter part of last year. The special report which I have pleasure in presenting has only recently been issued, and I should like briefly to refer to the fact that it divides itself into three headings, which have been already summarised.

The reports contain a vast amount of information, and in the limited time we have today, it will be impossible to go into every detail.

With regard to new locomotives, you will notice that there are no conclusions; that is because the locomotives referred to as having been constructed since 1930 have only recently been completed.

Test methods have been perfected, or are much nearer perfect than ever they were before. There is no standard basis for carrying out tests, and it has been suggested by Mr. Mascini that this would be valuable. A schedule might be prepared to which all locomotives to be tested would have to conform, and a strict comparison could then be made of the results.

I do not wish to say anything more about the details, except to compliment the authors, Messrs. Parmantier, Dugas and Mascini, on their very valuable conclusions.

I will now read out *Summary 1* :

1. There has not been any marked increase in boiler pressures since 1930. A pressure of about 284 lb./sq. inch (20 kgr./cm²) has been regarded as the limit for boilers of conventional design. A total steam temperature of about 752° F. (400° C.) appears to be the maximum which is desirable owing to difficulties with lubrication, and the effect due to creep of the metals in contact with the steam if this temperature is much exceeded.

The President (in German). — Does anyone wish to say anything about point 1 of the Summaries?

Mr. Parmantier, *Reporter* (in French). — In Summary 1, Sir Nigel Gresley says that a boiler pressure of about 20 kgr./cm² (284 lb. per sq. in.) is considered to be the limit for boilers of conventional design.

It might perhaps be better to say that a pressure of 20 kgr./cm² is *currently* used at the present time.

On the other hand, it says in the same summary : « A total steam temperature of about 752° F. (400° C.) appears to be the maximum desirable owing to difficulties with lubrication, and the effect due to creep of the metals... ».

Perhaps it would be better to say that though in fact it is difficult to exceed a figure of 400° C. at the present time, theoretically it would be an advantage to have a higher temperature than 400° C. for a pressure of 20 kgr./cm².

Mr. Günther, *Deutsche Reichsbahn* (in German). — Simple expansion is still possible with a pressure of 20 kgr./cm² (284 lb. per sq. in.). The construction and maintenance of simple expansion locomotives are obviously simpler and more economical.

Consequently the Deutsche Reichsbahn has built four new types of simple expansion locomotives, with 2 and 3 cylinders, and not compound locomotives

at it was said by mistake in the main report. When the pressure exceeds 20 kgr., the Reichsbahn also uses compounding.

By using special steels with a great resistance to heat, boilers with a higher pressure, and consequently greater efficiency, can be made as light as boilers of the same size for lower pressures.

As regards the maintenance costs of boilers of conventional design for high pressures, our experience is still not sufficient to lay down the law on this subject.

With simple expansion, the superheat temperature can be raised to 450° C. (842° F.) in view of the fact that the behaviour of the piston rings is principally dependent on the average temperature of the cylinder walls.

For the rest I agree with the alterations suggested by Mr. Parmantier.

Sir Nigel Gresley. — I wish to meet the remarks made by Messrs. Parmantier and Günther. The proposed Summary 1 was worded as follows :

1. There has not been any marked increase in boiler pressures since 1930. A pressure of about 284 lb./sq. inch (20 kgr./cm²) has been regarded as the limit for boilers of conventional design.

We might say : « ... can be regarded as the generally observed limit for boilers of conventional design ».

Mr. Günther points out that locomotives with a pressure of more than 20 kgr. (284 lb. per sq. in.) have been considered and have even been built; however, these locomotives are obviously not locomotives of the usual type.

Our experience of these new types, obviously is insufficient for any conclusions to be arrived at.

Consequently, I think we should be content with the slight alteration I have just mentioned.

Mr. Günther (in German). — The locomotives with a pressure of more than 20 kgr. I mentioned just now are of conventional design, and so are their boilers.

Mr. Mascini, *Reporter* (in French). — I am in complete agreement with Mr. Parmantier's suggestions as regards the boiler pressure and a superheat temperature of 400° C. (752° F.).

As regards the latter point, I would like to call the attention of the Meeting to the fact that lubricating difficulties are not very great if the locomotives are fitted with poppet valves instead of slide valve gear. On the Italian State Railways, for example, for 15 to 20 years we have had 350 to 400 locomotives with poppet valves which have given every satisfaction in service.

In my opinion therefore we should not deal with lubricating difficulties so categorically, but alter the wording a little to take into account the fact that this drawback can be avoided.

The President (in German). — Does anyone else wish to say anything about point 1?

Mr. Chapelon, *Paris-Orléans Railway* (in French). — It says in Summary 1 that « A total steam temperature of about 400° C. (752° F.) appears to be the maximum which is desirable... »

I think the word « desirable » is not accurate. The maximum temperature desirable is not just one particular temperature for all locomotives. It depends essentially on the type of the locomotive in question.

If we were dealing with a perfect engine, the calorific energy in the steam

would be completely transformed into work. If, on the contrary, we are dealing, as is actually the case, with a more or less imperfect engine, the heat is not completely changed into work. Instead of producing nothing but horse-power, the steam shows an increase in entropy, so that a greater amount of heat is required and there is unused heat in the exhaust steam.

Under these conditions, the superheat temperature required and really used is the less the more the locomotive in question differs from the ideal engine. In this case it is useless to raise the superheat temperature to any great extent, since even in the last phases of expansion there may not be condensation. The optimum degree of superheat should therefore be defined, not only from the theoretical point of view, but from the point of view of the real cycle of the engine.

In this connection it is as well to make a distinction between locomotives with but little wire-drawing, i.e. in which the expansion approaches the adiabatic expansion, and locomotives with a large amount of wire-drawing. We should also make a distinction between compound locomotives and simple expansion locomotives, as compound locomotives can in principle function with a lower degree of superheat than the latter.

Finally, I think it should be stated in Summary 1 that the maximum desirable superheat temperature is, in principle, above 400° C. (752° F.), but that it depends above all on the degree of perfection of the locomotive, and in particular on it being a simple or double expansion engine. All things being equal, moreover, simple expansion locomotives should have a higher degree of superheat than compound locomotives.

Sir Nigel Gresley. — Dealing with the point raised by Mr. Mascini and Mr. Chapelon, Mr. Mascini goes very fully into the point raised by Mr. Chapelon, in his detailed report. The proposal is perhaps a little vague, it would perhaps be simpler if we could say, « the maximum desirable for piston valve locomotives ».

Mr. Renevey, *Algerian Railways (Joint Management)* (in French). — I am in complete agreement both with Sir Nigel Gresley's first text for Summary 1 and with Mr. Chapelon. This may seem somewhat strange, but Mr. Chapelon told us that when designing a locomotive, we must find the superheat temperature that suits this locomotive, theoretically and experimentally.

I think we are all in agreement with this point which seems so obvious to me that I do not think it necessary to include it in the summaries.

In Summary 1, Sir Nigel Gresley states that the limiting temperature is 400° C. (752° F.). Like Mr. Chapelon, I would like to delete the word « desirable » and put « compatible with lubricating difficulties ». In fact what we must maintain is this maximum limit, which, if we agree, depends not on the working of the locomotive itself, but on questions of lubrication.

Mr. Poncet, *French Est Railways* (in French). — Though I agree with the suggestions put forward by Messrs. Chapelon and Renevey, I also want to draw attention to one particular point.

On the French Est we have some locomotives with the superheat temperature mentioned by the previous speakers. The only difficulties we met with from the point of view of lubrification were not on the valve gear side, but in the pistons and cylinders. We have used both slide

valve gear and poppet valves, without any serious lubricating difficulties.

For this reason, I do not think it necessary to make any distinction between poppet valves and slide valve gear when considering the desirable maximum superheat temperature.

The President (in German). — Does anyone else wish to speak?

Sir Nigel Gresley. — Dealing with the points raised by Messrs. Chapelon, Renevey and Poncet, I think we might modify the conclusion to read « maximum compatible with good lubrication », leaving aside any allusion to any particular system of valve gear, piston valves or poppet valves.

The President (in German). — So the wording would be :

« 1. There has not been any marked increase in boiler pressure since 1930. A pressure of about 284 lb./sq. inch (20 kgr./cm²) can be regarded as the generally observed limit for boilers of conventional design.

« A total steam temperature of about 752° F. (400° C.) appears to be the maximum compatible with good lubrication, and the creep effect of the metals in contact with the steam.

Does the Section agree to this amended text?

— *Adopted.*

Sir Nigel Gresley. — We now come to *Summary 2 :*

2. The enlarging of the steam pipes and passages has reduced the pressure drop between the boiler and steam chest, thereby improving the steam circuit.

I should like to modify that, and instead of simply saying « thereby improving the steam circuit », to mention back-pressure, or improved exhaust, and I suggest that the following be adopted,

« The enlarging of the live and exhaust steam pipes and passages has reduced the drop of pressure between the boiler and cylinder, and has facilitated the discharge of exhaust steam, thereby improving the steam circuit. »

Mr. Mascini (in French). — The new wording suggested by the Special Reporter meets essentially the new proposal I was going to make. I do think, however, a more general formula would be better. We might say, for example : « The enlarging of the steam pipes and passages between the boiler and the exhaust has improved the steam circuit ».

Sir Nigel Gresley. — I can hardly agree with the conclusion proposed by Mr. Mascini. It is so obvious to say that the enlarging of the steam pipes has improved the steam circuit and that further enlarging between the cylinders and blast pipes has facilitated the discharge of steam and reduced back pressure.

I think the suggestion put by Mr. Mascini is so vague that it does not help us very much.

The President (in German). — We are all in agreement essentially with the modified summary proposed by Sir Nigel Gresley, and I suggest that the Meeting approve this text.

Mr. Lancrenon, *French Nord Railway* (in French). — The amended text which the Special Reporter has just read meets the situation very well and I fully agree with it. I have one bone to pick with him, however : he only mentions the steam pipes and passages, i.e. the circulation of the steam, and completely ignores all that has been done to improve the exhaust in recent years, one of the fac-

tors which has contributed to the most important progress in improving locomotives.

It seems to me that we might add a paragraph saying that the progress made in the design of exhaust pipes has also played an important part in improving locomotives, by reducing the back pressure.

Sir Nigel Gresley. — I think the suggestions made would be included if we said : « The enlarging and improving of the live and exhaust steam pipes » ...and so on.

Mr. Lancrenon (in French). — We might add : « especially the design of blast pipe top ».

Mr. Renevey (in French). — I agree with Mr. Lancrenon that special mention should be made of the exhaust. This question in fact is important not only from the point of view given previously, but also in connection with the very power of the locomotive. I am, therefore, in favour of giving up the old wording for a more precise text, such as the following :

« The enlarging of the steam passages between the boiler and the exhaust has made it possible, by reducing wire-drawing and improving the steam circuit, to increase the power and the efficiency. »

In addition, *the exhaust* should have a paragraph to itself.

Sir Nigel Gresley. — I would prefer that we do not add anything more to our conclusions. I agree that this is an important point, but there are other points which are also important — the use of thermic syphons, for instance — but I think we must confine ourselves to generalities, and not enter into discussions of special devices.

Mr. Chapelon (in French). — In view of the importance of the exhaust question and the results obtained by improving the designs used during recent years in every country, especially in America and France, I do not think the Congress should pass over this important question in silence.

If the improvements made in locomotive design in recent years are considered in their order of importance, there is no doubt but that those relative to the exhaust head the list. Thus certain locomotives have been considerably improved by perfecting the exhaust even when the steam circuits remained defective. World wide experience seems to show the truth of this, and in such countries as the United States of America, for example, where the steam circuits have not been much altered in recent years, endeavours have been made to improve the exhaust.

One very interesting and novel fact is that all the improvements made to the exhaust in recent years in various countries have one thing in common : in every case the chimney has been made larger. There is no doubt that in modern designs the locomotive chimneys have been made too small. It would appear that this fact is now appreciated in every country. The American *Kiesel* exhaust, the Belgian *Legein* pattern and the types of exhaust used on the French Nord, Paris-Orléans-Midi, Est and P.L.M. have all taken this factor into account.

It should be recognised that the Deutsche Reichsbahn was the first to increase these dimensions; thus, on the *Pacific* locomotives built in 1921, the chimneys already had a diameter of 600 mm. (24").

It would seem to be necessary, therefore to call the attention of the Congress

to the importance of the exhaust and to the general principle of increasing the size of the chimney which all railways have adopted in order to increase the efficiency.

The President (in German). — I want the Section to vote on the new wording suggested by the Special Reporter, which I will read again :

« 2. The enlarging and improving of the live and exhaust steam pipes and passages has reduced the drop of pressure between the boiler and cylinders and has facilitated the discharge of the exhaust steam, thereby improving the steam circuit.

— *This text was adopted.*

Sir Nigel Gresley. — *Summary 3 :*

3. Interesting progress has been realised in the design of the exhaust, whereby the counter-pressure has been reduced, combustion improved, and the thermic efficiency of the locomotive improved.

The President (in German). — Has anyone anything to say about Summary 3?

Mr. Günther (in German). — I am sure the Meeting would be interested in the results obtained by the Reichsbahn with streamlined locomotives.

We have made comparative road tests with express class 03 4-6-2 or *Pacific* locomotives, some completely streamlined, and others without a streamline casing. The power developed at the drawbar, with an evaporation of 57 kgr. per m² (11.7 lb. per sq. ft.) of grate area per hour, were as follows :

At 100 km. (62 miles) an hour :
ordinary locomotive . . . . 1 260 H.P.
streamlined locomotive . . . 1 455 H.P.
i.e. an increase in power of 195 H.P. or 15.5 %;

At 120 km. (75 miles) an hour :
ordinary locomotive . . . . 1 075 H.P.
streamlined locomotive . . . 1 365 H.P.
i.e. an increase of power of 290 H.P. or 27 % ;
At 140 km. (87 miles) an hour :
ordinary locomotive . . . . 800 H.P.
streamlined locomotive . . . 1 185 H.P.
i.e. an increase in power of 385 H.P. or 48 %.

Streamlining also gave good results from a thermal point of view; the power developed in the cylinders was increased from 20 to 40 I.H.P., thanks to streamlining.

These favourable results, obtained from accurate trials at constant speed, are confirmed by the data collected during a year's experience with two identical class 03 locomotives working the same regular express train service. The fuel saving on the streamlined locomotive compared with the ordinary locomotive was 11.7 % per locomotive-kilometre and 15.2 % per locomotive tonne-kilometre.

The saving given by streamlining should be taken into account when it is a question of building locomotives for very high speeds.

The President (in German). — Does everyone agree about Summary 3?

— *This summary was adopted without any alteration.*

Sir Nigel Gresley. — *Summary 4 :*

4. The use of non-condensing turbine locomotives is being developed.

The President (in German). — Has anyone anything to say about Summary 4?

Mr. Mascini (in French). — It seems to me that the wording of this summary gives the impression that the development of turbine locomotives is already far enough advanced, whereas this is far from being actually the case.

I would prefer this summary to be altered a little, something like this :

« Tests are being carried out with turbine locomotives, with a tendency to abandon condensation. »

In my opinion this is a more accurate statement.

Sir Nigel Gresley. — I see no objection to the wording proposed by Mr. Mascini.

The President (in German). — Does everyone agree with the wording suggested by Mr. Mascini.

— *Approved.*

Mr. Renevey (in French). — Before we begin discussing the second part of the Summaries about testing locomotives, I would like to suggest including in the first part a special paragraph about the exhaust.

We have just been given some information about the savings due to streamlining.

On the French Railways we are convinced that these savings are indeed a concrete fact, but in addition it is possible to get just as great savings by improving the exhaust.

We, therefore, think the question of the exhaust just as important as that of streamlining, and I suggest that the Section should adopt the following text about this subject, the wording of which has been given a very general meaning :

« Interesting progress has been realised in the design of the exhaust, whereby the counter pressure has been reduced, combustion improved, and the thermic efficiency of the locomotive improved. »

Sir Nigel Gresley. — I have no objection to the wording proposed by Mr. Renevey.

The President (in German). — Does everyone agree that this additional summary be adopted?

— *This text was unanimously adopted and became Summary 3, the former summary 3 becoming Summary 4.*

Sir Nigel Gresley. — In the first part of the summaries we dealt with the improvements in steam locomotives of the usual types since 1930, as well as with tests of locomotives of new types built since 1930.

We now pass on to the second part of the summaries, relative to locomotive tests in experimental stations and out on the road.

The first of these summaries reads as follows :

5. Testing stations are regarded as essential for the scientific study, and the precise and comparative investigation of the design, performance and efficiency of locomotives and their components.

The President (in German). — Has anyone anything to say about this Summary?

— *No remarks were made.*

As no one wants to speak, I conclude that everyone agrees with the proposed text, which therefore becomes *new Summary 6.*

We will now take Summary 6 of the special report.

Sir Nigel Gresley. — *Summary 6 :*

6. Trials with dynamometer cars in con-

junction with brake locomotives form the best method of determining the maximum drawbar horse-power and fuel consumption of locomotives under service conditions.

The President (in German). — Any remarks?

Mr. Renevey (in French). — Though I agree with the proposed wording, I would like to make a few remarks.

Trials on the test plant and on the line with brake locomotives are obviously of great value, but neither completely reproduce the actual working conditions, and it sometimes happens that in actual service different results are obtained from those given by different trials.

I will only mention one example about which I believe Mr. Günther could give more complete details : the *Krupp* turbine locomotives which have been altered a great deal, and were dealt with in an article by Mr. Burmeister in « *Glasers Annalen* » of the 15th October 1935 (1).

During trials on the line with a brake locomotive and by the Grunewald method, these locomotives gave very interesting results which were not fully confirmed in service for reasons which were not and could not be discovered during the trials themselves.

Consequently I think it is imperative to say that tests on the test plant or running line should be in general completed by comparative tests in actual service, carried out as far as possible with a series of engines, not just one, over a fairly long period.

Mr. Günther (in German). — I can confirm Mr. Renevey's statements. Tests carried out on the test plant or with brake locomotives cannot take the place of trials in actual service; it is therefore very important to complete test plant trials by trials in actual service.

Of course it is necessary to make tests at constant speed and power to get accurate comparative results.

In the case of the turbine locomotive in particular, this was tested on the test plant and with a brake locomotive; these tests showed a 30 % saving in fuel consumption, but as soon as the locomotive was put into regular service this saving was reduced to between 14 and 16 %.

It is true that the fuel consumption was compared with that of the new class 01 and 03 express locomotives, whereas the turbine locomotive was built in 1923.

Anyhow, I am in complete agreement with Mr. Renevey's additional summary, which states that tests on the test plant should be completed by putting a certain number of locomotives into regular service.

Mr. Mascini (in French). — I would like to give you some information about the practice on the Italian State Railways in this connection.

We have always been accustomed to continue or complete the trials made on a locomotive in current service or on a train, or later on by means of the brake locomotive, by comparative service trials with several locomotives.

The results of service runs have always been very like those given by the trials.

However, I am inclined to agree with Mr. Renevey's proposal, the object of which is to complete the results of special trials.

Mr. Renevey (in French). — The wording I suggest is :

« It is generally essential that the results of trials on the test plant or line be checked by comparative trials under working conditions over a long period. »

(1) See *Bulletin of the Railway Congress*, July 1936, p. 707.

Mr. Bulleid, *London and North Eastern Railway*. — I think the proposed wording is too strong. It would be better to say « useful » rather than « essential ».

Mr. Parmantier (in French). — I want to ask Mr. Renevey what results he expects to get from trials under working conditions.

Trials with brake locomotives make it possible, in particular, to get accurate figures on the increase in power due to a given alteration. What else can we expect to get from trials in service apart from verifying the proper working of the altered locomotive?

Mr. Renevey (in French). — Further comparisons are made possible. When a locomotive to which some new device has been fitted has shown a saving of 15 % on the test plant, in my opinion it is impossible to make a general statement and say that by fitting this device a saving of about 15 % will be obtained in service. This 15 % saving has to be checked in ordinary service. It is quite easy to do this. The P.L.M., to which Mr. Parmantier belongs, and to which I had the honour to belong for twenty-one years, in my time — I do not know if it is still the practice — went to work in the following way : a series of ten locomotives fitted with the new device were put into service together with ten others without it. Every two months the drivers of each group were changed over, and after one or two years the average consumption figures were obtained, which enabled the two groups to be compared.

Sir Nigel Gresley. — Mr. President, it does not seem to me to be necessary to state in the conclusions what is the usual practice for checking, under service conditions, new devices or even new locomotives. Locomotives are built to work a certain service, and they must be checked in that service. It seems quite unnecessary to amend the conclusion to include something which has been common practice ever since I joined the railway service.

I think it is hardly necessary, therefore, to re-adjust the conclusion on that subject.

The President (in German). — I have come over to Sir Nigel Gresley's way of thinking, and I suggest we do not include the addition proposed by Mr. Renevey in Summary 6 (new 7).

— *Summary 7 (formerly No. 6) was adopted without any modification.*

We will now go on to Summary 7 of the special report, which becomes No. 8.

Sir Nigel Gresley. —

7. It is desirable that all Railways should agree a standard programme for the testing of locomotives, both at a testing station and under service conditions with dynamometer car and brake locomotive, so that accurate comparative results can be obtained.

Mr. Dugas, *Reporter* (in French). — I recognise the value of the recommendation just read. I am a little sceptical, however, about the possibility of railways exchanging figures with complete confidence, not in the case of figures relating to power and tractive effort, as these seem to be obtained with a definite accuracy, but consumption figures, because as soon as it is a question of consumption it is necessary to specify the kind of fuel used; in the reports it is customary to give an elementary analysis of the fuel, i.e. its calorific value, though there is not always agreement about whether this applies to the maximum or minimum calorific value — the volatile and ash content.

Unfortunately this is not sufficient, and we have had occasion to appreciate, when making careful trials on the line that some of the characteristics of fuel which it is not the general practice to determine, such as the coking power, have a direct influence on the consumption figures.

For this reason I think that in formulating the recommendation to exchange figures — a recommendation the value of which is obvious — it must be recognised that in practice only figures relating to the power and tractive effort can be exchanged, and that a thorough investigation would be required before questions of consumption can be profitably dealt with.

Mr. Poncet (in French). — I think Mr. Dugas' remark is a very wise one, but in my opinion it proves the care that must be taken in comparing figures.

On the other hand Mr. Dugas said that only figures relating to the power and tractive effort could be compared. I think we should add to these factors the steam consumption of the engine which is not affected by any of the errors Mr. Dugas has just mentioned.

In the case of the fuel consumption obtained with an improvement, it is easy to understand that to compare the figures got out by different railways, the quality of the fuel used must be taken into account. In any case there is one thing that can serve as a basis of comparison : the saving of fuel, no matter what fuel, provided this saving is the result of the same improvement being made to a locomotive.

In my opinion all that is necessary is to define the way in which the information regarding the results of similar tests on different railways is to be given.

Mr. Ogurek, *Polish State Railways* (in German). — I think that to get comparable figures, it is as well to follow the trials on the test plant according to Professor Czeczott's method, which is to use two locomotives on the train, one of which is working at constant, and the other at variable, power. Under these conditions, the results obtained can easily be compared. Could this be mentioned in the Summaries?

Mr. Parmantier (in French). — May I point out in this connection that the Czeczott method mentioned by Mr. Ogurek was described in our report.

The President (in German). — I think we should not include too many details in the summaries, because they must be of a general nature.

Consequently I want to know if the Meeting agrees with the wording suggested by the Special Reporter for this last summary?

— *Summary 7 (new 8) was unanimously adopted.*

The President (in German). — Gentlemen, this brings us to the end of the discussions on Question V. I thank all those who have taken part in these discussions and given valuable details about the practice on their respective railways.

I am particularly grateful to Sir Nigel Gresley, the *Special Reporter*, as well as the other reporters for their valuable collaboration to the work of the Congress. *(Applause.)*

Sir Nigel Gresley. — On behalf of the Reporters, I also wish to sincerely thank the President for the able way in which he presided over our discussions. *(Loud applause.)*

— The Meeting ended at 12.15 p.m.

DISCUSSION AT THE PLENARY MEETING

June 7th, 1937.

MR. HENRY-GREARD, VICE-PRESIDENT, IN THE CHAIR.

GENERAL SECRETARIES : MESSRS. P. GHILAIN, DE BOYSSON AND CAMBOURNAC.

ASSISTANT GENERAL SECRETARIES : SIR H. NIGEL GRESLEY AND DR. TH. KITTEL.

The President. — We will now examine the Summaries for Question V.

I call upon Mr. Ghilain, the General Secretary, to read these out.

Mr. Ghilain, *General Secretary.* — The text of the Summaries for Question V was published in the *Daily Journal of the Session,* No. 4, of the 5th June.

(Mr. Ghilain read all the summaries in turn.)

The President. — Are there any remarks?

As no objections are being raised, these summaries are taken as adopted.

Summaries.

« 1. There has not been any marked « increase in boiler pressure since 1930. « A pressure of about 284 lb./sq. inch « (20 kgr./cm²) can be regarded as the « generally observed limit for boilers of « conventional design.

« A total steam temperature of about « 752° F. (400° C.) appears to be the ma« ximum compatible with good lubrica« tion, and the creep effect of the metals « in contact with the steam.

« 2. The enlarging and improving of « the live and exhaust steam pipes and « passages has reduced the drop of pres« sure between the boiler and cylinders « and has facilitated the discharge of the « exhaust steam, thereby improving the « steam circuit.

« 3. Interesting progress has been rea« lised in the design of the exhaust, « whereby the counter-pressure has been « reduced, combustion improved, and the « thermic efficiency of the locomotive « improved.

« 4. The scientific streamlining of lo« comotives appreciably reduces air « resistance at high speeds, and there« fore increases the horse-power availa« ble for traction.

« Streamlined locomotives of the reci« procating type, specially designed for « extra high speed working, have been « introduced by several Administrations « since 1930.

« 5. Tests are being carried out with « turbine locomotives, with a tendency « to abandon condensation.

« 6. Testing stations are regarded as « essential for the scientific study and « the precise and comparative investiga« tion of the design, performance and « efficiency of locomotives and their « components.

« 7. Trials with dynamometer cars in « conjunction with brake locomotives « form the best method of determining « the maximum drawbar horse-power « and fuel consumption of locomotives « under service conditions.

« 8. It is desirable that all Railways « should agree a standard programme « for the testing of locomotives, both at a « testing station and under service con« ditions with dynamometer car and « brake locomotive, so that accurate com« parative results can be obtained. »

[621. 33]

QUESTION VI.

Methods and devices used, in connection with electric traction, to save current between the supply side of the power station and the driving wheels (feeders, substations, tractors), and in particular the use of mercury rectifiers.

Preliminary documents.

Report (Great Britain, Dominions and Colonies, India, North and South America, China, Japan), by C. E. Fairburn. (See *Bulletin*, January 1937, p. 73, or special issue No. 14.)

Report (Switzerland, France and Colonies, Spain, Portugal and Colonies, Italy, Belgium and Colony, Luxemburg, Netherlands and Colonies, Egypt), by Messrs. Eggenberger and Eckert. (See *Bulletin*, March 1937, p. 641, or special issue No. 21.)

Report (Austria, Germany, Denmark, Norway, Sweden, Finland, Poland, Hungary, Czechoslovakia, Jugoslavia, Bulgaria, Rumania, Greece, Turkey), by E. R. Kaan. (See *Bulletin*, March 1937, p. 705, or special issue No. 22.)

Special Reporter : C. E. Fairburn. (See *Bulletin*, June 1937, p. 1528.)

SECTIONAL DISCUSSION.

Meeting held on June 8th, 1937.

Professor Dr.-Ing. WECHMANN in the Chair.

— The Meeting opened at 9.30 a.m.

The President (in German). — Gentlemen, today we have to examine question VI, which is of present interest for the majority of Railways.

I assume that each of us is provided with the reports relative thereto, as well as with the special report, and I propose to follow the customary procedure by examining one by one the summaries set down by Mr. Fairburn in his special report.

I will call upon Mr. Fairburn, *Special Reporter*, to speak.

Mr. Fairburn *(Special Reporter)*. — Gentlemen, I have the honour to present to you on behalf of my fellow Reporters and myself, the reports which we have drawn up on question VI. The question is concerned primarily with current savings but the Reporters realised that the study of this in itself is not sufficient and that savings must always be related to total costs. The question is framed

with special reference to mercury rectifiers. I think everyone will agree with me in believing that from now on rectifiers will play an important part in the future of electrification.

As we have a large number of summaries to deal with, I will now read *the first :*

1. Proposals for saving current cannot be considered on purely technical grounds, but must be related to the total cost to the railways, of the service performed.

The President (in German). — Does anyone wish to make any observations about Summary 1?

No remarks being forthcoming, Summary 1 was adopted.

Mr. Fairburn. — *Summary 2 :*

2. In addition to savings due to improvements in the equipment, which cannot be expected to make a great difference in the total energy consumption, direct savings in the energy required and in the recovery of energy by regenerative braking demand serious consideration.

The President (in German). — Is everyone in agreement with the adoption of this point?

— *Adopted without comment.*

The President (in German). — We now come to the very important section dealing with *mercury vapour valves (converters).* This matter forms the subject of *Summaries 3 to 9.*

Mr. Fairburn. — *Summary 3 :*

2. The most important contribution of recent years to the improvement of electric traction equipment, particularly as regards saving energy, is the mercury-vapour converter. In its full development it will tend to displace all types of rotating converters now in use.

The President (in German). — Gentlemen, during the last few years, the German Reichsbahn has carried out a very large number of tests on the mercury vapour converter, with particular reference to the conversion of three-phase current to single-phase. About 12 years ago the whole Metropolitan system of Berlin was equipped with rectifiers converting three-phase current to direct current. From the point of view of efficiency and ease of control, the results obtained have been highly satisfactory. In addition, in the course of a single year we have achieved an economy of current representing 3/4 million marks. In the light of these results, we have continued our researches with a view to producing equipment capable of converting three-phase to single-phase current. The perfecting of these phase converters has occupied several years. In December 1936, we were able to put into operation the first apparatus of the type we call « Starrer Umformer » (invariable ratio transformer). It has operated for more than six months without the least hint of failure.

I, therefore, propose to slightly modify the text of Summary 3, and to say that the mercury vapour valve is at the present time in the development stage, but that when development is complete, this apparatus will replace the rotary transformer to the same degree that the mercury vapour rectifier is already replacing the A. C. to D.C. rotary converter.

We might, therefore, combine Summaries 3 and 4 in a single paragraph. Summary 4 states as a matter of fact :

4. For the conversion of alternating to direct current, the rectifier can already be

regarded as the standard unit in new installations.

Mr. Fairburn. — I quite agree with the amendment proposed by Dr. Wechmann.

Mr. Parodi, *Honorary Director of Electrification, Paris-Orléans Railway, and member of the French Local Organising Commission* (in French). — I would like a rather more precise definition of what is meant by « transformateur rigide » (Starrer Umformer) of which mention has just been made by the President. In French the term is ambiguous. I would like to know whether it refers to a converter of three-phase to single-phase current.

The President (in German). — It is a question of frequency ratio. When a three-phase 50-cycle supply is converted to single-phase, the latter will have a frequency in the exact ratio of 50 : 3 or 16 2/3 cycles, when what we term the « Starrer Umformer » is used. On the other hand, the so-called asynchronous converter allows a frequency ratio which differs from the invariable ratio, e.g. 50 and 16 1/2, 50 and 17, etc. In fact, it often happens that the frequency of current supplied by a generating station not belonging to the railway, is not exactly that of the traction current.

Mr. Parodi (in French). — I am of course, entirely, in agreement with the President on the substance of the question. It is merely a matter of arriving at a mutual understanding on the meaning of the term « transformateur rigide ». It is a question of a converter in which the incoming and outgoing currents are in a constant frequency ratio, but, in my opinion, the term « transformateur rigide » is not plain in French.

Mr. Eggenberger, *Reporter* (in French). — I am of the opinion that the question of the constant or variable frequency-ratio converter ought not to be handled in summaries 3 and 4. Summary 3 is of a general nature : Summary 4 refers to the conversion of three-phase to direct current. I consider, therefore, that we ought rather to raise this point in Summary 6 which could be slightly modified in this way.

Mr. Cardon, *Paris-Orléans Railway* (in French). — I note that in his statement the President has with advantage stressed the point that the mercury vapour valve is at present in its development stage.

On the other hand, summary 3, in my opinion, gives the impression of a very sweeping condemnation of rotary converters.

It is true, the Special Reporter has pointed out that he has excluded the economic aspect of the problem.

But, even from the constructional point of view, one cannot lose sight of the fact that rectifiers with their various pumps, anode grids, grid excitation equipment and various auxiliaries, are at the moment complicated pieces of apparatus necessitating far from negligible maintenance. The present improvements have as their principal object the elimination of back-firing. Now, we have found that the methods adopted are not yet completely efficacious. Until this efficacy is attained, operating troubles will result (very often the vacuum falls and the plant is out of service) ; furthermore if the high-tension circuit breaker feeding the transformer does not trip, there is a risk of damage to the transformer, and if the H.T. circuit breaker opens there is a danger that repeated tripping on short circuits will cause failure of the circuit breakers.

The better to outline the present state of the problem, I would remark that a definite specification has not yet been established for rectifiers, especially as regards compound rectifiers, and that in particular the overload conditions admissible in rectifiers are quite different from those allowed in converters. If it is admitted that rectifiers should be able to carry the same overloads as converters, it must be stated also that these overloads, however small, must not be applied suddenly.

I may add, in conclusion, that these miscellaneous remarks refer to 1 500-volt traction supply. The problem quoted by the President concerned 3 000-volt current, can be viewed in quite a different light and already can be considered in a manner more favourable to the mercury rectifier.

To sum up, we are well still in the development stage, and the condemnation of the rotary converter seems to me, I will not say crude, but all the same too sweeping and hasty, if one may judge by the text of the Special Reporter when he says, « it will tend to displace all types of rotary converters now in use », whereas in actual fact it is not yet fully perfected.

The President (in German). — I quite agree, and that is why I propose to modify slightly the text before us. My proposal is to say that the development of the mercury vapour valve is not yet complete.

Mr. Fairburn. — Actually the proposed alterations correspond with what I had in mind when using the words « in its full development ». I wonder if it would not be possible to interpret the French text in the same sense; as in fact it reads : « ... quand ce genre d'équipement aura atteint sa pleine evolution... ». I think this is how Mr. Parodi wishes to interpret this clause. *(Messrs. Parodi and Cardon made affirmative signs.)*

Mr. Chantrell, *Principal Secretary.* — I think it would be as well for us to read the rough draft of Summary 3 which is to replace Summaries 3 and 4 of the special report.

« 3. The most important contribution of recent years to the improvement of electric traction equipment is the mercury vapour converter.

« This type of equipment has not yet reached its full development; it is however possible to predict that, in the near future, this development will reach a point where the mutator (1) will replace the rotary converter in the same measure as the rectifier at present replaces the rotary converter for the conversion of alternating current to direct current.

The President (in German). — Are we agreed on this text?

— *Adopted.* (This text replaces the former summaries 3 and 4.)

Mr. Fairburn. — *Summary 5 :*

5. The mercury-vapour inverter has proved satisfactory for reconverting direct to alternating current in the substations of direct-current lines employing regenerative braking.

The President (in German). — Does

(1) The term « mutator » appearing here and elsewhere in these proceedings is used as the translation of the French term « mutateur » put forward to cover all possible applications of the mercury vapour converter, i.e. not only conversion of A.C. to D.C. as solely implied by the term « redresseur » (rectifier), but also conversion of D.C. to A.C., of A.C. of one frequency to A.C. of another, of either the same or a different number of phases.

anyone wish to say anything about summary 5?

Mr. Nicolet, *French State Railways* (in French). — I would like to know if any Companies yet possess adequate experience of the use of the inverter as applied to regenerative braking.

I believe that the Italian State Railways have employed it for this purpose. What other Administrations use it? It has probably not been in use very long.

If the Delegates here present or the Special Reporter could give us any additional information on this point, it would be most useful.

Mr. Fairburn. — On the South African Railways mercury converters are being used successfully for regenerative braking. This Administration has been testing equipment of this type for 2 or 3 years and, as a result, now has on order a number of units to extend its installation.

The President (in German). — Is anyone yet in a position to furnish the results of any trials which have been made of the mercury vapour valve for regeneration?

Mr. Fairburn. — As regards the South African Railways, may I point out that particulars are given in the last column of the table, page 63 of my report *(Bulletin,* January 1937, p. 135).

Mr. Parodi (in French). — I consider that this isolated experience does not seem to justify a statement as definite as that appearing in Summary 5, in which it is stated, « The mercury vapour inverter has proved satisfactory... ».

I have asked several firms to let me have their proposals in this connection and I have never been able to obtain them.

Mr. Fairburn. — I think the South African Railways are certainly satisfied or they would not have undertaken this further large expenditure.

The President (in German). — I associate myself with the remark made by M. Parodi. It is true, Mr. Fairburn has told us that the experience of the South African Railways has been perfectly satisfactory, but that has reference to one Administrations only, while on other systems equally interested in the question of regeneration the results have been less satisfactory.

That is why I think we should amend the wording of Summary 5 by saying, for example :

« The good results obtained by one Railway Company with the use of the mercury vapour inverter for regenerative braking will no doubt encourage other Companies using direct-current systems to improve the rectifier with that purpose in view ».

Mr. Parodi (in French). — I would still like to ask, as a matter of interest, whether in the equipment used by the South African Railways, this conversion of direct to alternating current is effected by means of one rectifier tank or of two.

Mr. Fairburn. — The South African installations are of the two-tank type.

The President (in German). — It is not possible to effect this other than by employing two tanks, one tank for each half-wave.

I will now ask you to be good enough to support the amendment I have proposed.

— *The Summary was adopted in the final form given below and became the new No. 4.*

« 4. The mercury vapour inverter has proved satisfactory on one Administration for reconverting direct to alternating current in the substations of direct-current lines employing regenerative braking. This will no doubt induce other Administrations with direct-current systems to seek further improvements in the same direction.

Mr. Fairburn. — *Summary 6 :*

6. Theoretical problems raised by the use of the mercury-vapour converter for the conversion of three-phase current to either single-phase current or to three-phase current of another frequency have been solved, but practical difficulties remain and present installations must be regarded as experimental.

The President (in German). — I should like to modify the wording of Summary 6 in order to take into account the remark made just now by Mr. Eggenberger. We might say that the fixed frequency-ratio transformer has given good results, and after that, as regards the different types of variable-frequency ratio transformers, that the latter have not yet emerged from the experimental stage.

Are you agreed on the general import of this proposal?

Mr. Karlsbad, *Polish State Railways* (in French). — I think it of importance that we should employ a more precise terminology.

To speak of a « fixed frequency-ratio transformer » or a « variable frequency-ratio transformer » is not sufficiently exact, seeing that the word « transformer » is applied to an entirely different piece of apparatus.

I think Mr. Parodi would agree to substituting « ... *mutateur* à rapport de fréquence constant... » (fixed frequency-ratio *mutator).*

Mr. Parodi (in French). — I have no objection.

The President (in German). — Is everyone in agreement with the following wording of this Summary, which will now become the new No. 5.

« 5. The fixed frequency ratio mutator has given satisfaction for the conversion of three-phase current to single-phase current of low frequency (Reichsbahn).

Several types of mutators of variable frequency ratio have been tried. It cannot, however, be predicted yet, which of these systems will eventually give satisfaction. »

— *This summary was adopted.*

Mr. Fairburn. — *Summary 7 :*

7. Grid control equipment is an inherent part of the mercury-vapour converter for all uses except as a rectifier. In addition to its main function the equipment can be adopted to control the output voltage and to interrupt the main arc for protective purposes; in some cases it may be worth while adding it to a rectifier to give these features.

The President (in German). — I would like to make an observation about this paragraph. At first it is stated that « grid control equipment is an inherent part of the mercury vapour converter for all uses, except as a rectifier... » then, at the end of the paragraph, « ... in some cases it may be worth while adding it to a rectifier to give these features ». We believe that grid control equipment is used today for all types of mercury va-

pour converters. It is of use alike in modifying the secondary voltage between given limits and in effecting the rapid breaking of the arc. For three years the Berlin Metropolitan has made use of it with good results.

I, therefore, propose to omit the end of the first sentence « for all uses except as a rectifier », and to amend the wording of the second sentence by omitting in particular the whole of the final portion, beginning at « for protective purposes... ».

Mr. Fairburn. — I think this is a question of terminology. The French text reads « L'équipement de grilles polarisées fait partie *intégrante* du convertisseur à vapeur de mercure » which means that this equipment is essential; this justifies the end of the sentence «sauf quand celui-ci sert de redresseur.»

The President (in German). — I agree with Mr. Fairburn. My observation about the end of the first sentence was inspired by the fact that the German wording of the Summary does not correspond exactly with the English and French versions. An alteration to the German text is necessary, and in these circumstances I am in agreement for retaining the whole of the first sentence.

Mr. Parodi (in French). — I entirely agree with the President's statement. Nevertheless, in the French version, I think we ought to omit the last four lines : « dans l'intérêt de la sécurité; dans certains cas, il pourra être utile de l'adjoindre à un redresseur pour lui conférer ses qualités (« for protective purposes; in some cases it may be worth while adding it to a rectifier to give these features »). After all, the same statement is made twice.

The President (in German). — Is everyone in agreement with the adoption of the modified wording as follows :

« 6. Grid control equipment is an inherent part of the mercury vapour converter for all uses except as a rectifier. In addition to its main function the equipment can also be adopted for all types of mutators to control the output voltage and to interrupt the main arc.

— *The latter was unanimously adopted and became the new No. 6.*

The President (in German). — I would like to say further that the use of the mutator has given good results on our locomotives on the Höllental line. For those of you who may be interested in the results obtained with this equipment in this particular case, I may say that a description of it has appeared in the publication « Elektrische Bahnen », and that my copy of the latter is at their service.

We now come to Summary 8.

Mr. Fairburn. — *Summary 8 :*

8. In cases where ripples in the output of a rectifier cause interference in communication or signal circuits, the provision of resonant shunt filters provides a satisfactory solution.

The President (in German). — The German text is as follows :

« In cases where ripples in the current from the rectifier cause induction effects in telephone lines and signal circuits, the use of resonant shunt filters provides a satisfactory solution. »

That is correct, but we also have need of filters in the case of alternating current, not only to safeguard communication and signalling circuits, but for all purposes. In my opinion « mutator » should be substituted for « rectifier »

Has anyone any further observations to make?

Mr. Cardon (in French). — It is stated in Summary 8 that « the provision of resonant shunt filters provides a satisfactory solution. »

To my knowledge there are nevertheless, in the matter of traction, two distinct cases to consider in the production of direct current, namely the compound rectifier and the shunt rectifier.

We have shunt rectifiers giving entire satisfaction when equipped with coils : in other respects the latter constitute an additional complication and are not in themselves free from breakdown.

As I have had no experience of shunt rectifiers other than that which I have just quoted, and as the use of compound rectifiers is still in the initial stage, I would like to know whether we are in a position to affirm at the moment that the use of resonant shunt filters presents an entirely satisfactory solution to the problem stated.

Mr. Karlsbad (in French). — I too think that it is a little premature to talk of a « satisfactory solution » at the moment.

The trials we have carried out on our system are of recent date and have not given entire satisfaction. Whenever a mercury vapour rectifier installation is put in, difficulties are almost invariably encountered : the telegraph service, for instance, always accuses the railways of occasioning a great deal of interference. This is notably the case with the Polish railways, where, despite the use of filters, the solution adopted is not entirely satisfactory.

In this connection I should like to know the characteristics desirable in a rectifier filter in order to cut out all interference. At the moment, no definition exists of a filter giving universal satisfaction.

I should also like to know whether a satisfactory solution of the problem has been produced by any Administration.

The President (in German). — I am in a position to give Mr. Karlsbad some information on this point. In Germany, we had some initial difficulties, especially in connection with telephone communications; these disturbances were eliminated by the installation of filters. However, last year we experienced still worse trouble; during a whole day international telephone communication with Switzerland was completely cut off. A long study of the question has at length enabled us to give complete satisfaction to the Post Office. It has been the same with regard to radio installations. The question has been a long and difficult one to solve, but at last good results have been obtained, and today the international telephone and telegraph services to Switzerland operate in an exemplary manner. May I ask Mr. Karlsbad for how long his Company has been struggling with these difficulties and what are the circumstances in which they have arisen?

Mr. Karlsbad (in French). — The electrification of railways in Poland is of comparatively recent date. Public electric services have only been in operation for six months, following a trial period of six months.

From the first day of trial running, and in spite of the installation of filters — all substations are equipped with them — the Telephone and Telegraph Service has made complaints, especially in connection with international communications. I would like to remark by the way that in my opinion the Post Office

always has a tendency to exaggerate slightly when any question of interference by rectifiers arises.

There has certainly been some interference : in particular it has been definitely established that on railway signalling circuits very curious interference has been encountered, which has led to the untimely operation of certain signals.

On railway telephone lines this interference has not assumed such proportions, since certain precautions have been taken.

In reply to another question of the President, I would say that the electrified lines under discussion are those of the Warsaw group, i.e. two or three lines serving the suburbs of the capital and comprising about 20 km. (12 1/2 miles) each.

Mr. Fairburn. — In the United States of America, in 1935, I made a special investigation into this subject and found that in all cases, with the possible exception of radio reception, any troubles encountered had been overcome. The experience of the Southern Railway in England with certain early difficulties was the same.

Mr. Cardon (in French). — In order to take all these observations into account we might perhaps word the summary thus :

« Resonant shunt filters are used when ripples in the output... ». The wording will thus merely be reversed. I should like to add, however, that naturally, if it is stated that filters are employed, it is an indication that in general they give satisfaction to the Administrations concerned.

Mr. Fairburn. — I am not in agreement with the wording proposed by Mr. Cardon, because I think we should state not only that filters are used but also that they are satisfactory in the circumstances indicated in the summary.

The President (in German). — Is the section in agreement with the wording suggested by the Special Reporter?

Mr. Cardon (in French). — In consideration of the request made by the Special Reporter, I will not insist on the inversion which I suggested; but while keeping the form of the proposed wording we might replace the phrase « provides a satisfactory solution » by « always effects a considerable improvement and often gives a satisfactory solution »

Mr. Parodi (in French). — I think that it would be much better to keep the wording of the summary in the form proposed by the Special Reporter.

Basically, what we mean, and what we are quite certain of, is that we always extricate ourselves from difficulties, but that does not mean to say that we manage it at the first attempt.

Mr. Cardon (in French). — It is understood that we will use the word « mutateur » in place of « redresseur ».

The President (in German). — The wording would consequently be as follows :

« In cases where ripples in the output of a mutator cause interference in communication or signal circuits, the provision of resonant shunt filters provides satisfactory solution.

Are we all in agreement?

— *This summary was adopted and became the new No. 7.*

Mr. Fairburn. — Summary 9 :

9. The water-cooled steel tank type un

s most widely used but the glass bulb type nd also the newly developed low-capacity ir-cooled type form useful alternatives for ome applications.

The President (in German). — Does he section agree with the proposed wor- ng?

— *Summary 9 was adopted and be- ame the new No. 8.*

The President (in German). — We have now come to the end of those sum- maries dealing with mercury vapour val- ves (converters), and we start on trans- mission systems, which form the subject of Summaries 10 to 13.

Mr. Fairburn. — *Summary 10 :*

10. A separate transmission system purely for railway use is best when the generating plant is used wholly for railway purposes.

Mr. Parodi (in French). — I should like to make some general observations regarding the four summaries referring to transmission lines.

The summaries formulated here should in principle be such as either to serve as a guide to Administrations in their oper- ation or researches, or to help them in their dealings with other organisations.

I am of the opinion that Summaries 10 to 13 are not of sufficient interest and I propose that they be omitted.

The President (in German). — I should like to hear the opinion of the Special Reporter on this subject.

Mr. Fairburn. — The four summaries, Nos. 10, 11, 12 and 13 are based on the replies received from the different Ad- ministrations. Summaries 11, 12 and 13 are as follows :

11. A combined railway and industrial transmission system can be adopted with advantage when the railway network is widespread and covers territory having a large industrial load.

12. High-tension direct-current transmis- sion, although offering possible transmission savings, is not yet commercially practicable.

13. Leakage and corona losses on high- tension transmission lines can be overcome by established methods such as the use of guard rings and hollow cables.

I am in agreement to some extent with Mr. Parodi's proposal. Our summaries should serve to guide our Member Admi- nistrations and in this case we might de- lete Clauses 10 and 11. However, we should retain clause 12 which states :

« High-tension direct-current trans- mission, although offering possible transmission savings is not yet commer- cially practicable ».

This actually expresses a fact which would serve to guide the Railways.

As regards Clause 13, this gives in- formation which is well known by all Administrations. Perhaps we might de- lete Clauses 10 and 11 and retain Clauses 12 and 13.

The President (in German). — With reference to Summary 12, there seems to be a slight descrepancy between the French and German texts; the French text states « ... is not yet industrially possible... », while the German wording is « ... not yet workable for economic and practical reasons... ». In Germany we have also come to the same conclusions as Mr. Fairburn regarding direct current for traction purposes. Transmission sys- tems for high-tension direct current are very expensive. Technically the idea is possible, but from the economic point of view it is unworkable.

Mr. Parodi (in French). — In the form suggested, Summary 12 is absolutely inadmissible, since there are in existence high-tension direct-current transmission systems, notably at Lausanne and Grenoble.

If reference is not being made to these direct-current systems, the fact should be stated. If it is a question of direct-current transmission systems employing mutators, that also should be mentioned, but it cannot be stated that high-tension direct-current transmission is not yet industrially possible, since as a matter of fact it has been achieved in certain instances.

Mr. Fairburn. — It is well known that technically this is quite practicable but it is not so economically. Otherwise why is it that almost all transmission lines are three-phase?

Mr. Parodi (in French). — We are entirely in agreement; that is why I think it would be much better to omit the summary since we can gain no new information from it.

With reference to the Grenoble installation I have mentioned, I believe it is about to be superseded and replaced by an alternating-current system, a fact which well illustrates that the first method of transmission was not economical.

The President (in German). — What is the voltage of the Grenoble equipment?

Mr. Parodi (in French). — It is in excess of 75 000 volts; I believe it has been as high as 100 000 or 120 000 volts. The maximum figure reached has certainly been above 75 000 volts.

The President (in German). — I too am of the opinion that it is perhaps a little premature to pronounce a verdict on the subject of high-tension direct current.

Is everyone agreed to the omission of Summary 12?

— *Summary 12 was deleted.*

The President (in German). — As regards Summary 13, which merely states a well-known fact, I am in favour of omitting that also.

Is everyone agreed?

— *(Agreed.)*

We have, therefore, decided on the complete deletion of Summaries 10 to 13, that is, those relating to transmission lines.

We now come to that part of the business relative to *Substations*.

Mr. Fairburn. — *Summary 14 :*

14. The substations must be arranged to feed the contact system at a sufficient number of points to give a low contact system loss without unduly heavy construction.

The President (in German). — The German text does not appear to me to be quite clear. I believe it is a question of substation spacing, so calculated that they may feed the lines, etc.

Mr. Nicolet (in French). — In brief the aim of this clause is to state that modern methods at the present time tend towards the elimination of the feeder and its replacement by a larger number of substations.

If this is the view taken by the Special Reporter, I think that the wording of this summary could be made more precise and that instead of « at a sufficient number of points » we might say « a sufficiently short distance apart » and, in

lace of « constant system loss », « to void voltage drop ».

Mr. Fairburn. — That is actually the neaning of summary 14. Formerly the endency was to place substations at fair- y long distances from each other and to rovide conductors of large cross section. ince the introduction of the mercury ectifier, it has been found better to spa- e the substations more closely, thereby ffecting a saving of copper in the con- uctors.

The President (in German). — Do you uggest a new wording for Summary 14?

Mr. Parodi (in French). — I am in fa- our of leaving the wording as it is, ex- ept for substituting « voltage drop » for line losses ».

The President (in German). — Ought e not to say that we aim at an economy n copper?

Mr. Fairburn. — I agree and propose o say : « ... voltage drop... ».

The President (in German). — Is veryone in agreement?

Mr. Eggenberger (in German). — nstead of « without unduly heavy con- rruction », we might say « in order to void excessively heavy methods of con- ruction ».

Mr. Parodi (in French). — We could ay « without any undue increase in the eight of conductors ».

The President (in German). — I think e are in general agreed on the wording be employed. I would suggest that I ave a final version prepared, to be sub- mitted for our approval at tomorrow's Meeting. *(Agreed.)*

We now come to Summary 15.

Mr. Fairburn. — *Summary 15 :*

15. On A. C. lines this can be effected by intermediate feed points between main substations in which simple, preferably out-door, equipment is used and controlled either from the nearest railway station or by a remote control system.

The President (in German). — I am not very clear as to the meaning of the expression « intermediate feed points ».

Mr. Eggenberger (in German). — The solution adopted by the Swiss Federal Railways is as follows : When the line between two substations is rather long, we interpose a single transformer operated by the staff of the nearest station. Any other system of control is in consequence unnecessary.

The President (in German). — I am in favour of amending the original wording slightly, so that we may profit by the information imparted by Mr. Eggenberger. We could say more accurately :

« On altenating-current lines this can be effected by the introduction between substations of intermediate feed points provided with a simple transformer controlled either from the nearest railway station or by a remote control system. »

Are all in favour?

— *This summary was adopted as No. 10.*

Mr. Fairburn. — *Summary 16 :*

16. On D. C. lines the same result can be obtained by the use of remote-controlled single unit rectifier substations.

The President (in German). — Are we all agreed on the proposed wording?

— *Summary 16 was adopted as the new No. 11.*

Mr. Fairburn. — *Summary 17 :*

17. The additional cost of remote-control as compared with automatic control is normally justified by the increased flexibility given to the system.

Mr. Parodi (in French). — May I ask that the wording should read « ... completely automatic control... ».

In France, there are, as a matter of fact, substations termed automatic which are not so actually and in which the staff is as large as in the manual substations.

The President (in German). — For my part, I am in agreement with the proposal.

Are all in favour of this modification?

Summary 17 was adopted with this addition and became the new No. 12.

Mr. Fairburn. — *Summary 18 :*

18. The mobile substation can sometimes be used with advantage to meet seasonal traffic fluctuations.

The President (in German). — Do you approve of the wording of Summary 18.

Mr. Cardon (in French). — It is stated that « The mobile substation can sometimes be used... to meet seasonal traffic fluctuations », but it is also used for other reasons and especially in case of breakdowns.

The President (in German). — I would draw attention to the fact that the German version says « temporary » in place of « seasonal ».

Mr. Parodi (in French). — I would suggest putting « ... to meet temporary operating needs ».

The President (in German). — Is everyone in agreement?

— *Summary 18 was adopted, subject to the amendment proposed by Mr. Parodi, and became the new No. 13.*

Mr. Fairburn. — *Summary 19 :*

19. No appreciable improvement in transformer efficiency can be secured except at excessive cost.

Mr. Parodi (in French). — It appears to me that we might without detriment omit Summary 19, which states nothing in any way new. The same may be said for Summary 20 which is a repetition of a summary already adopted. In fact, the latter states :

20. The efficiency of rotating converting plant is inherently low; an improvement can be secured by the substitution of mercury-vapour converters.

The President (in German). — I was about to make the same suggestion as Mr. Parodi.

Are we agreed in completely omitting items 19 and 20?

— *The omission of Summaries 19 and 20 was approved.*

The President (in German). — We now come to Summaries 21 to 23 referring to *Contact systems.*

Mr. Fairburn. — *Summary 21 :*

21. In reducing contact system losses attention must be given to both the rail return circuit and to the contact line or conductor rail.

Mr. Parodi (in French). — I would

suggest the omission of this paragraph, since it is quite evident that to reduce losses, attention should be directed to both components of the conductor system.

I think we ought to pass on at once to Summary 22.

The President (in German). — I was about to voice the same opinion.

Mr. Fairburn. — I intended this clause to be merely an introduction to the question.

The President (in German). — Are we all agreed on the omission of Summary 21?

— *The omission was approved.*

Mr. Fairburn. — *Summary 22 :*

22. On alternating-current lines, operating at high voltage, the contact system losses are readily reduced to a reasonable value and any special steps are usually needed to prevent communication circuit interference rather than to save current.

The President (in German). — It seems to me that the German text requires a slight modification; this modification will not, however, affect the English nor French versions.

— *Summary 22 (English version) was adopted and became the new No. 14.*

Mr. Fairburn. — *Summary 23 :*

23. On D. C. systems the losses are higher, and special consideration must be given to the question of securing a reduction. Apart from increasing the contact line section or rail section, these include improved bonding by welding, and the cross bonding of tracks and contact circuits.

The President (in German). — Does anyone wish to make any remark?

Mr. Parodi (in French). — In this text, it states : « apart from increasing the contact line section or rail section... »; it would be better to put « Apart from increasing the conductor section... »

The President (in German). — Do you support this amendment?

— *Summary 23 modified accordingly was adopted as the new No. 15.*

The President (in German). — We now come to the heading « *Rolling stock* ».

Mr. Fairburn. — *Summary 24 :*

24. The weight of alternating-current locomotives is now comparable with that of direct-current locomotives for similar duties, and in both cases questions of adhesion prevent any large reduction in weight. Some reduction can be anticipated from fitting « fine » regulators and devices which transfer weight from carrying to driving wheels during starting.

The President (in German). — In my opinion the first sentence of Summary 24 is not sufficiently explicit.

I would like to mention in this connection that the weight of the Reichsbahn's E. 18 class locomotive, which is an express locomotive, is less than that of the French direct-current machine. The German alternating-current locomotive has only two pairs of carrying wheels, while the French locomotive has four pairs. Generally speaking, the alternating-current locomotive is inclined to be lighter than the direct-current type. However, without dwelling on this distinction, which is after all of minor importance here, we could simply say that the weight of electric locomotives has been considerably reduced in the last few years.

Mr. Fairburn. — I am in general agreement with the President's proposal.

Mr. Parodi (in French). — I think we should add « for equal horse-power; apart from that the locomotive weight is governed by its adhesion. What you wish to say is that the total weight of the locomotive has diminished. It should be added that the adhesive weight is governed by operating requirements.

The President (in German). — For a locomotive with eight driving wheels with a weight of 20 tonnes per axle, this weight of 80 tonnes must be kept as adhesive weight.

Mr. Parodi (in French). — I quite agree with the President on the general meaning of the summary, but it seems to me that we ought to modify the wording and say for example :

« The overall weight of electric locomotives has considerably decreased in the last few years, for equal horse-power ».

The President (in German). — « ... and equal tractive effort... »

The final wording would be as follows :

« The weight of electric locomotives for equal horse-power and tractive effort has been considerably reduced during the last few years. »

Is everyone in agreement?

— *This wording was adopted and became the new No. 16.*

Mr. Fairburn. — *Summary 25 ;*

25. Streamlining of locomotives, as a means of saving energy, is of relatively small value unless the whole train is similarly treated.

Mr. Koller, *Czechoslovakian State Railways, Vice-President* (in French). — It might perhaps be as well to combine 25 and 27. It appears to me to be more logical to deal first with Summary 26 which refers entirely to the weight of rolling stock, and then to combine summaries 25 and 27 which refer to streamlining.

Mr. Fairburn. — I will read Summary 26 :

26. Weight reduction is the most important means of saving energy on motor coach stock. This may be attained by changes in construction and by the use of special materials. Changes in construction include the combination of the body with the underframe and the use of welding, while special materials may be divided into light alloys and high-tensile steels.

Mr. Koller (in French). — I think it would be better to give this summary a more general form. Instead of saying « Weight reduction is the most important means of saving energy on motor coach stock », we might put : « Weight reduction on vehicles is the most important means of saving energy. »

Mr. Fairburn. — In my opinion weight reduction is a much more important factor in the case of motor coaches.

Mr. Koller (in French). — I suggest saying :

« Weight reduction, particularly of motor coach stock, is the most important means of saving energy », the remainder of the clause being retained.

The President (in German). — Are we all agreed on this amendment?

Summary 26, with this amendment was adopted as No. 17.

Mr. Fairburn. — Here is the text of the former Summaries Nos. 25 and 27 combined.

27. Streamlining of locomotives, as a means of saving energy, is of relatively small value unless the whole train is similarly treated.

Streamlining is of value on high-speed trains, but questions of interchangeability and variable train make-up tend to restrict it to set trains and single-unit coaches.

Mr. Günther, *Deutsche Reichsbahn* (in German). — I am of the opinion that we still under-estimate the importance of streamlining. We have not yet experimented in this direction with electric locomotives, but I can give you the results of trials carried out on steam locomotives. With a partly streamlined locomotive, without protective aprons for the motion, and at a speed of 140 km. (87 miles) an hour, trials have shown an economy in energy of 27 %. With a *completely streamlined* locomotive at the same speed, the economy has been of the order of 48 %. In ordinary service the streamlined locomotive has made possible a saving in coal of 11.7 % for a speed range of 60 to 140 km. (37.3 to 87 miles) an hour, in comparison with a standard locomotive of the same type. By streamlining the whole train we have achieved a diminution in resistance of 13 % at 140 km. (87 miles) an hour, as compared with a standard train composed of D (corridor) coaches.

Moreover, I believe that electric locomotives streamlined in the same way would give better results.

Mr. Koller (in French). — Taking Mr. Günther's remarks in consideration, I think we should first say as a general statement :

« Streamlining is of service for high-speed trains », and then : « It is best that the whole trains should be streamlined as much as possible », the rest of the original wording being deleted.

Mr. Santini, *Secretary.* — The text might then be worded as follows :

« For high-speed trains the streamlined form has a large influence on the consumption of energy. The maximum result will be obtained from the complete streamlining of the whole train set. »

The President (in German). — Are we all agreed?

— *This wording was adopted and became the new summary No. 18.*

Mr. Parodi (in French). — Just now Mr. Günther quoted some economy figures that he had previously mentioned during the discussion of Question V relating to steam locomotives.

I think there must be some misunderstanding of the basis of calculation. It is difficult to concede that the coal consumption could be reduced by about 50 %. I do not wish to start an argument, but I would like to draw attention to the statement nevertheless.

Mr. Günther (in German). — We carried out our tests first of all on small models in a wind tunnel, then on the line with streamlined locomotives, at different speeds. Each test was performed at constant speed. The figures quoted are obtained from tests carried out with very great care. It is scarcely necessary to add that to obtain them the locomotive had to be really streamlined in the most complete sense of the term.

The President (in German). — Gentlemen, I propose to postpone till tomorrow the continuation of the discussion of Question VI.

The Meeting was adjourned at 1.0 p.m.

Meeting held on June 9th, 1937.

PROF. DR.-ING. W. WECHMANN IN THE CHAIR.

The Meeting opened at 9.30 a.m.

The President (in German). — Gentlemen, at yesterday's Meeting we discussed Summary 14 and we agreed that a new wording should be suggested today. This text has already been published in today's issue of the *Daily Journal of the Session;* as a consequence of the omission of several summaries, Summary 14 is now numbered 9.

The suggested new wording is as follows :

« 9. The substations should be situated at sufficiently short intervals to ensure a low voltage drop in the contact system, although only the minimum of copper and other materials is used in the construction of the contact system itself and in the substations. »

Are we agreed on this wording?

Mr. Eggenberger (in French). — I suggest the omission from the German text of the word « gegenseitig », the equivalent of which does not figure at all in the English and French versions.

The President (in German). — Subject to this amendment to the German text, with which we are in agreement, are all in favour of the proposed wording of Summary 9?

— *Approved.*

We will now go on with the examination of the other Summaries for Question VI and turn to Summary 28 of the Special Report, referring to *Roller bearings.*

Mr. Fairburn. — *Summary 28 :*

28. Roller bearings are used as much to reduce lubrication and maintenance costs as to save energy; in consequence they are found more widely on motor coaches than on locomotives, and have been applied to motor armatures more frequently than to the locomotive or train axle journals.

The President (in German). — Has anyone any remarks to offer in this connection?

No remarks being forthcoming, Summary 28 was adopted as the new No. 19.

Mr. Fairburn. — *Summary 29 :*

29. The operating advantages of electric coach heating over fuel-fired boilers are such that boilers are normally adopted only in cases where the stock is hauled by both steam and electric locomotives, and they cannot be regarded as a means of saving energy.

The President (in German). — Are there any observations?

Mr. Cardon (in French). — I do not consider it correct to state that « ... boilers are *normally* adopted only in cases where the stock is hauled by both steam and electric locomotives... ». I think that instead of « normally », we should say « possibly ». On those systems which have both types of traction, electric and steam, the tendency is to employ electric coach heating.

We consider that as the normal method, and we must, therefore, say « ... are possibly adopted where the stock is on hauled... ».

Mr. Fairburn. — I agree to the proposal to substitute « possibly » for « normally ».

Mr. Parodi (in French). — It seems to me that we ought to state in the summaries what is the normal and usual practice.

I believe that almost all the electrified Railway Systems have adopted electric heating by radiators or air conditioning, and that heating by means of a boiler is exceptional.

Why not say that the normal heating system is by electric radiators? I think that we should start with that.

Mr. Fairburn. — I think, to reconcile these conflicting points of view, we should not include either « normally » or « possibly » and we should say simply « oil fired boilers are used only in the case of... »

Mr. Hayashi, *Japanese Government Railways.* — My opinion is that this summary ought to be deleted. It is not concerned with a method of saving current, but only with the choice of a heating system. Now the object of Question VI is current savings, whereas this summary only speaks of the selection of a heating method to meet operating requirements, and not to save energy.

Mr. Cardon (in French). — Nevertheless I think we can retain the paragraph seeing that it states in general terms the economical solution of the train heating problem.

I am in agreement with Mr. Parodi in stating that the usual method, even in the case of lines — this is the general case — with both electrified and steam sections, is to add some means of electric heating to the coaches.

In order not to upset the wording, I suggested substituting « possibly » for « normally ».

I consider that if we retain the general outline of the text, it would be better to put « possibly » so as to shew clearly that the usual solution is electric heating.

In short, I am in favour of stating that the normal method is electric heating, as the President and Mr. Parodi have said.

The President (in German). — This idea is expressed in the German version, but in a form which does not correspond with the French version. I will complete the German version in agreement.

Are you in favour of retaining Summary 29 as it stands, while replacing in the existing German version the word « normalweise » by « eventuell »?

Mr. Parodi (in French). — I must really insist on amending the French text of Summary 29. I suggest saying :

« Electric carriage heating is normally employed on the majority of electrified systems. Fuel-fired boilers are only installed in the case of stock hauled... ».

Mr. Fairburn. — I am in agreement with the wording now proposed by Mr. Parodi. I think it is better than the original text.

The President (in German). — I would like to draw attention to the case of coaches running over both electrified and steam lines. In this instance the stock in question should be equipped with two heating systems.

Mr. Nicolet (in French). — I do not think the new wording quite applies to actual practice, unless the steam locomotive's boiler is included under the heading « fuel-fired boilers ».

It is possible to produce — actually there is already in existence — rolling stock provided with two heating systems, one by steam from the locomotive, and the other electric. That is a third combination which has not yet been mentioned in the text of the summary.

Mr. Fairburn. — This summary was intended to draw attention to the fact that when fuel-fired boilers are installed this is done not to save current but for some different purpose. That is to say, when electric heating can be used, it is adopted and when fuel-fired boilers are used, the reason is not to save current.

Mr. Ribitch, *Jugoslavian State Railways* (in German). — I agree with Mr. Hayashi's proposal and would like to advance it on my own account, for since Question VI deals with economy in current consumption it is difficult to find a wording agreeable to all parties.

Mr. Parodi (in French). — I am absolutely convinced that we should retain this summary, seeing that in all the discussions we have had with the opponents of electrification a great point is always made of the difficulties which beset the problem of heating.

It is essential that the Electrical Engineers taking part in the present Congress state definitely that electric heating works well and is a normal and economical method of heating; it is even the most economical of all systems devised or tried up to the present.

Mr. Fairburn. — I am entirely in agreement with Mr. Parodi.

The President (in German). — I also support Mr. Parodi's point of view.

Mr. Karlsbad (in French). — I can only support Mr. Parodi's remarks and I agree with his attitude. I would merely add that the opponents of railway electrification invoke as their principal argument the difficulties caused by the heating of electrically-hauled trains. On the Polish Railways we have trains worked partly on electrified lines and partly on steam lines.

The intermediate operation over electrified lines is fairly short (10 km. = 6 miles) but we have nevertheless to maintain an uninterrupted system of heating during the winter.

We, therefore, found ourselves faced with great dificulties.

It is true we have thought of employing electrically-heated boilers, but in this connection we have only received tenders from one firm.

I should like to know whether any similar situation has arisen on any other railway, and whether perhaps electrically-heated boilers have had to be installed.

I may add that on our system electrical operation is at 3 000 volts, and that the trains in question are formed of coaches from different countries, and belong to the numerous international services working over our lines.

The President (in German). — The Reichsbahn has equipped all its D (corridor) trains with steam and electric heating. Results have been very satisfactory, for coaches thus equipped can operate at will over both electrified and steam lines. Moreover, we have discovered that electric heating of a boiler is complicated and not very economical.

I would say further that we also employ electric air heating. Of course steam heating of the air can be employed equally well.

In short, we have selected the simplest system combining the two methods of heating in the same coach.

We can understand the difficulties experienced by the Polish Railways arising from operation at 3 000 volts. However, experiments in electric heating are on foot on the French, German and Italian Railways with 1 500-volt direct current as well as 3 000 volts and single-phase current at 15 000 volts at the collector.

Could we not agree to the following text, the wording of which is improvised and could be improved :

« The economic and technical advantages of electric heating are so appreciable that it could with advantage be installed in all coaches operating on electrified lines : this system is very economical in comparison with heating by fuel-fired boilers ».

Mr. Parodi (in French). — May I suggest the following wording, in which I have endeavoured to take the various observations into consideration.

« Electric heating of vehicles is normally adopted on most electrified systems, the steam heating apparatus being maintained. Fuel-fired boilers are used only in the case of vehicles drawn by both steam and electric locomotives, but they cannot be regarded as a means of saving energy ».

Mr. Fairburn. — I think the proposal made by Mr. Parodi is certainly the best.

The President (in German). — Are we all agreed on the wording suggested by Mr. Parodi and approved by the Special Reporter?

— *The wording was agreed and became the new No. 20.*

Mr. Fairburn. — *Summary 30 :*

30. The fitting of thermostats on electric heating systems, by assisting the train staff in controlling the coach temperature, often leads to considerable energy saving.

The President (in German). — Does anyone wish to make any remarks in this connection?

Mr. Cardon (in French). — I think we should omit from this summary that part of the sentence reading « by assisting the train staff in controlling the coach temperature », considering that the very aim of thermostats is to control the temperature without having recourse to the staff , and with a larger saving of current.

The President (in German). — Are we agreed on the omission of this part of the sentence?

— *The summary was adopted subject to this omission and became No. 21.*

Mr. Fairburn. — *Summary 31 :*

31. The use of a single electric heater in conjunction with a system of hot air ducts in each coach may be more economical than the fitting of a number of electric radiators, as the preheating time can be reduced.

This summary was put in this form because from the information which we have obtained, it is difficult to say what economy can be obtained. In fact it is difficult to decide, at the moment, whether or not any economy at all can be realised.

Mr. Parodi (in French). — I quite agree with the last part of this paragraph. However, I would suggest a few amendments to the French wording.

Instead of : « L'emploi d'un seul appareil de chauffage... » I would suggest : « L'emploi d'un seul radiateur électri-

que... » (1), and instead of « ... car il permet de réduire le temps de préchauffage », I would say : « compte tenu de la réduction du temps de préchauffage » (taking into account the time required for preheating), seeing that there are still other advantages.

The President (in German). — So far as we are concerned on the Deutsche Reichsbahn we have proved the economic advantages of air heating. In certain special instances we have arranged as follows. The electrically-heated air is introduced into the coach and the vitiated air is replaced and expelled. In this way we effect the necessary heating and ventilation : furthermore, the cost is less. Considered by itself, electric radiator heating is less expensive, but if the cost of ventilation by means of fans is taken into account, the balance is tipped in favour of electric air heating, especially since this results in continuous renewal of the air.

Mr. Nicolet (in French). — I am entirely in agreement with the President's remarks. The stock which has just been constructed for suburban service on the French State Railways is equipped with heating by means of blown air, intended to increase comfort and ensure ventilation, a fact much appreciated by the public, since many of these trains are packed with passengers.

This stock, which is on exhibition at St. Lazare Station for the benefit of the Delegates, who can also study constructional details at the Gaillon shops, completely meets the conditions stated in Summary 26 studied at yesterday's Meeting. I must apologise for not being present at that Meeting, but I quite agree with the meaning of that summary which is entirely in agreement with the method of construction of the stock in question, as regards weight saving achieved by the use of special high-tensile steels.

The President (in German). — To give expression to the remarks made in the course of the discussion, we might adopt the following final sentence for Summary 31 : « In fact, it allows of a reduction in the time required for preheating and in the weight of the coaches; furthermore, it leads to a saving of current in the case of ventilation. »

Mr. Fairburn. — I am in agreement with the addition proposed by the President.

Mr. Parodi (in French). — I would suggest putting « ... taking into account the time required for preheating, the ventilation realised, and the lightening of the vehicles ».

The President (in German). — Is everyone in agreement with the amendment suggested by Mr. Parodi?

— *This Summary was adopted in the form proposed and became the new No. 22.*

Mr. Fairburn. — *Summary 32 :*

32. In winter, the maximum energy demand of a train can be reduced by cutting out the heating system when accelerating or ascending heavy gradients.

The President (in German). — About 10 years ago we employed on our Hamburg suburban lines a method of disconnecting the electric heating supply during accelerating periods and thus achieved some saving in current. On the

(1) The English wording remains unaltered in this respect.

other hand, this also involved some drawbacks, chiefly on the score of insufficient heating. However, since we are considering an isolated case here, I think we might agree to the proposed text. We must certainly make a distinction between energy consumption and the cost thereof. In Germany, electrical supply contracts are agreements based on maximum power and not on effective energy consumption, and hence it is advantageous to cut off the heating supply during acceleration and on steep gradients.

I think, therefore, the text might remain as it is. Are you in favour of retaining the present wording?

Messrs. **Parodi** et **Cardon**. — Yes.

Mr. Villeneuve, *Midi Railways*, France (in French). — I imagine that when speaking of « maximum energy consumption » we have in mind the power absorbed by both train and heating. It is a question of effecting a saving of energy. Now, if we reduce the energy demand and cut off the heating while starting, since the train must be supplied with a certain number of calories during the run, these must be furnished, and, therefore, more heat must be supplied at other times.

When the heating supply has been disconnected while starting, as was done at Hamburg, it was found that the train was insufficiently heated. Hence, during stops, extra heat must be supplied. It is not a measure calculated to achieve a saving in current consumption.

Mr. Kaan, *Reporter* (in German). — I think that the remarks made by Mr. Villeneuve may be quite correct from a theoretical point of view, but they are not true in practice, since, generally speaking, our stock is always over-heated. The preheating in the stations is so intense that in actual fact the trains are over-, rather, than under-heated.

In my opinion there is no disadvantage attached to interrupting the heating supply during accelerating periods or on steep gradients.

Mr. Karlsbad (in French). — It is not merely a question of current saving, but of lessening the costs. Now, as the President has said, with certain forms of contract — as is the case on our own System — maximum demand is the basis for payment. For this reason I think it advisable to agree to the summary proposed by the Special Reporter. As Mr. Villeneuve has said, the calories lost by cutting off the heating during starting have to be supplied, but in any case, by arranging the maximum demand in a suitable way, the cost may be reduced according to the terms of the contract, although there is no saving in the total consumption of energy.

Mr. Nicolet (in French). — I can agree with these remarks if I may be allowed to extend the scope of the question slightly, since at present it only deals with a saving in current; now, we are speaking at the moment of a saving on tariff charges.

Taking this point of view, I would mention that in the very dense electrified suburban service from Saint-Lazare Station we have also been induced, as a means of effecting a continuous saving in tariff charges, to cut out the heating for periods of fifteen to twenty minutes, although these periods are not exactly the same on all sections of the suburban service, in order to lower the peak current during those periods when traffic is most dense, in particular during the morning hours.

The current being cut off for a quarter of an hour, according to the section of line, results in a saving of several hundred thousand francs at the end of the year.

It is, therefore, a question associated with the one which has just been discussed.

Mr. Villeneuve (in French). — I quite agree with Mr. Nicolet.

The President (in German). — Does anyone wish to make any further observations?

Mr. Karlsbad (in French). — If I request permission to speak, it will not be on the subject of Summary 32, but really to add a new summary. We are about to conclude the discussion of electric heating and pass on to the section dealing with regenerative braking. Before entering on this point, I would like to ask whether the Assembly does not consider that the addition of a new summary is required.

All the previous speakers have stressed the advantages of electric heating. Now, as I have had occasion to mention just now, there are international trains which run over electrified lines, and the coaches forming these trains, drawn from various Systems, are not all equipped with the apparatus necessary for electric heating.

I would mention by the way that direct electric heating at 3 000 volts has been used with success on our lines. We have encountered no difficulties.

I consider then that coaches running over international lines ought to be equipped with the necessary apparatus, and I propose the addition of a summary to this effect, in which the suggestion should be made to the various Companies — within the possible limits, as I realise that it is not easy — that international coaches should be provided — as on the Reichsbahn — with combined heating apparatus, in order that electric heating may be employed on electrified lines.

The President (in German). — I think we should first of all settle summary 32, and then look into the suggestion put forward by Mr. Karlsbad.

Mr. Nicolet (in French). — I suggest the following wording for Summary 32, seeing that, as stated just now, it is not a question of consumption but of payment.

« In Winter the peak load of energy can be reduced by cutting out the heating system when accelerating or when ascending steep gradients, or during the periods of heaviest traffic. »

The President (in German). — I am entirely in agreement with Mr. Nicolet, inasmuch as I was about to make a suggestion to the same effect.

Are we agreed on the wording proposed by Mr. Nicolet?

— *This text was adopted and became Summary 23.*

The President (in German). — We can now examine the suggestion made by Mr. Karlsbad.

Mr. Kaan (in German). — I would like to say that for about twelve years the Austrian Federal Railways have owned coaches equipped with both electric and steam heating. Nevertheless I do not propose to support Mr. Karlsbad's suggestion; this question is not within the sphere of the Congress, but is rather a matter for the International Railway Union. In addition, it has not been touched upon in the reports and we must

ıot lose sight of the fact that the summa-ies we adopt should reflect the ideas ex-ɔressed in the reports.

Mr. Fairburn. — I agree entirely with)r. Kaan and I suggest that the diffe-ent systems of heating have nothing to lo with the saving of current, which is, fter all, the subject of our report.

Mr. Karlsbad (in French). — I am uite in agreement with the observations hat have just been made on the subject f my proposal. I had suggested that he Congress make a recommendation on his matter, but as the question is out-ide its jurisdiction, I withdraw my sug-estion.

The President (in German). — We ow come to the section dealing with *Re-enerative braking*, which forms the sub-ɔct of Summaries 33 and 34.

Mr. Fairburn. — *Summary 33 :*

33. Present systems of regenerative brak-ıg which operate only above a relatively igh speed, are of value only on lines aving long heavy gradients.

The President (in German). — Has nyone any observations to offer?

Mr. Cardon (in French). — May I ask or an amendment to that part of the entence which says « which operate only bove a *relatively high* speed ». That is ery vague, since there are actually sys-ems of regeneration which operate from 0 km. (25 miles) an hour upwards, a peed which cannot be described as re-ıtively high ».

In practice the equipment is expensive nd heavy; it is only worth considering herefore in connection with locomotives or use on steeply graded lines, but the apparatus is such that regeneration can profitably be used when locomotives so equipped operate on relatively light gradients.

Mr. Fairburn. — I agree with Mr. Cardon that the words « relatively high speed » are not very good but they were used to distinguish between summaries 33 and 34. In the latter we are dealing with braking systems which can be operated down to standstill and the words « relatively high speed » make this distinction. I find it somewhat difficult at the moment to offer a suitable alternative unless we were to speak of « a certain speed ».

Mr. Parodi (in French). — Everyone is agreed on the general meaning; it is only a question of the form.

It seems to me that we might adopt a phrase that we have used at different times, and say « Present systems of regenerative braking, which operate solely for *retarding purposes...* »

The President (in German). — We must differentiate between two kinds of regenerative braking : first of all, braking employed on gradients, not necessarily to decrease the speed of the train, but simply to prevent it from exceeding a certain maximum speed; next we have what we term decelerative braking, which can be kept in operation until the train has come completely to rest. This is quite different from the first named.

Mr. Parodi (in French). — I quite agree. We might say perhaps « ... which operate solely to counteract gravity effects », instead of « ... for retarding purposes ».

Mr. Fairburn. — In English the sense

could be rendered very well by the words « appreciable speed ».

Messrs. **Parodi** and **Cardon**. — « ... a certain speed. »

Mr. Fairburn. — Agreed.

Mr. Graff-Baker, *London Passenger Transport Board*. — May I suggest that the wording for this conclusion might read, « Systems of regenerative braking at present in service, since they do not operate down to low speeds » and so on, continuing to the end.

Mr. Bacqueyrisse, *Member of the French Local Organising Commission* (in French). — I think the Special Reporter is aiming at a distinction between two different regenerative systems in Summaries 33 and 34; one of these does not operate below a certain speed, which just now was given as 40 km. (25 miles) an hour : the other, which forms the subject of Summary 34, is the system now on trial, which operates at low speeds.

We must, therefore, differentiate between the uses of the two ssytems.

With a view to putting it on record, may I advance some information appertaining to Summaries 33 and 34?

Under the heading « Regenerative braking », in his special report Mr. Fairburn states :

« Detailed information about these systems is not yet available but on one large City service the results so far obtained have led to a large-scale experiment which, it is anticipated, will effect a very large reduction in energy consumption and brake block wear. Such braking systems are, at the moment, confined to D.C. lines. »

In my double role of General Manager of the Suburban System in question (Société des transports en commun de l Région parisienne) and of advocate o regenerative equipment, at present unde discussion, I would like to say a fe words about the use of compound mo tors in direct-current electric traction.

First of all, I would like to run briefl over the results of what on account of it size may no longer be termed an experi ment.

175 tramway cars of the « Société de transports en commun de la Région pari sienne » equipped between 1929 an 1932 with compound motors for regene ative purposes, have run 15 million k (9.3 million miles) up to the 15th Marc 1937, with the following favourable r sults:

— an energy saving of 20 to 35 % a cording to the section of line, with mean saving of 25 % for the whole sy tem;

— 60 to 80 % saving in brake block

— 15 to 20 % saving in tyres;

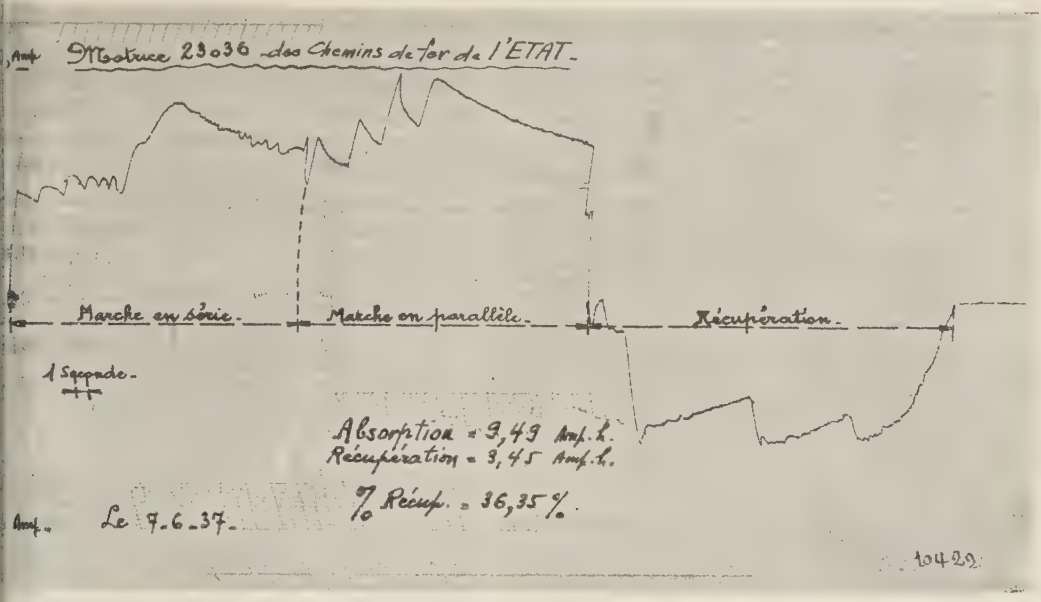
— reduction in feeder line losses, d to the increase in the mean voltage du ing regeneration;

— reduction of accidents, owing to fective and safe braking, since with th braking system it is impossible for t wheels to pick up;

— lastly, of greatest importance, i crease of the average speed thanks to t speed/time curve it is possible to ado with compound motors.

On account of energy saving alone, t cost of modifying the standard series m tor equipments to form regenerati compound motor equipments has be written off in less than 18 months.

In my capacity of Reporter on question « Energy regeneration » at 25th Congress of the International Uni of Tramways, Light Railways and Mo Transport Undertakings », due to open



Explanation of French terms:

lotrice... = motor coach No. 23036 of the French State Railways. — Absorption = consumption. — Récupération = regeneration. — Marche en série (en parallèle) = Working in series (in parallel.

Vienna in three weeks time, I have had he satisfaction of pointing out in my report the continued increase in the number of regenerative equipments in use on European Tramway Systems. The number rose at the 1st January 1937 to nearly 00 (excluding trolley-bus equipments) nd the greater part was formed of compound motor equipments.

Now, under what conditions could thee equipments, which have worked so satisfactorily on the tramway systems, be pplied to rolling stock on the main-line ailways?

I have no hesitation in declaring emhatically : « with extreme simplicity nd with very great profit to those Railways ».

The French State Railways have been he first to undertake some trials and at he present time are producing a motor oach with 4 compound motors obtained by a simple modification to 4 series motors. Owing to various delays in the work of modification the trials only commenced yesterday, and I much regret that they could not have taken place sooner, so that the results, which are certain to be most interesting, could have been communicated to this Assembly.

I am placing at the disposal of those who may be interested a graph (reproduced above) shewing a starting and regenerative braking cycle carried out yesterday, with the equipment under discussion.

This graph shews a regeneration ratio of 36 % for operation on the level and a maximum speed of 70 km. (43.5 miles) an hour, reached in 44 seconds, i.e. with an acceleration of 0.40 m. (1.22 ft.) per sec. per sec. up to this speed.

In spite of these interesting results, I have no hesitation in stating that the use

of the compound motor is not advantageous merely on the score of savings in energy consumption, for, as Mr. Schwend, Manager of the Nuremberg-Fürth line, has written lately, even if there is no saving in energy, the use of this motor would be well worth while simply from the improvement it introduces in operating conditions and rolling stock performance.

As a matter of fact, I have already mentioned the advantage — of capital importance at the present time — of the increase in average speed that this motor renders possible owing to two characteristics which it is well to remember :

1. possibility of adopting a speed/time diagram with the highest possible average speed for a given maximum speed;

2. the horizontal tendency of the speed/tractive resistance curves, which renders the speed almost independent of the gradients of the line and eliminates the drops in speed on gradients such as those mentioned by Mr. Bachellery in connection with the Capvern bank on the Midi System, where the speed drops to 45 km. (28 miles) an hour for a speed on the level of 90 km. (56 miles) an hour (1).

Starting from these considerations, the Edinburgh Tramways System has made experiments as to the increase in overall speed attainable when all energy saving is neglected. This has worked out at 15 %. This figure requires no comment.

In the same way, by putting up the running speed to the maximum permissible, the Nuremberg System has reduced to 16 % the saving in energy, which could have been, at the former averag speeds, about 29 %, having preferred t take advantage of a real gain in overa speed.

I have thought it advisable to stres this point, because it shews the substan tial, but often little known, advantages o the compound motor in direct-curren electric traction.

I have also mentioned the improvemen it makes in operating conditions.

In the first place it makes for grea er simplicity of control than the serie motor. It will, of course, be appreciate that it is easier and less troublesome t control the speed of a vehicle — wha ever it may be — by modifying the re latively small current of a shunt excit tion than by acting on circuits traverse by the whole traction current. In add tion to which it is possible to obtain much smoother gradation of the tractiv efforts and resisting torques and th makes it possible to increase — for equ adhesion limit — the values of the acc lerations and decelerations.

As I proved, thanks to practical appl cations, to the Congress of the Intern tional Union of Tramways, Light Ra ways and Motor Transport Undertaking held in Berlin in 1935, the compoun motor lends itself more easily, and wi a simpler circuit arrangement, to aut matic, and especially multiple-unit, co trol, than does the series motor.

In addition to the safety in braki and the reduction of contact system lo ses already mentioned, I would also em phasise the reduction in wear of bra blocks and, consequently, tyres.

This matter is not only important fro the point of view of reducing maintena ce costs and the heating of tyres on lo down-gradients, but also for Syste using a third-rail contact line in that

(1) Address dated 14th November 1930, from Mr. Bachellery to the French Institution of Civil Engineers (Proceedings of the *Société des Ingénieurs de France*, No. 1, January 1931, p. 82.

eliminates the metallic dust which sometimes makes its presence known in such a disagreeable way.

Finally, a very important point, the use of the compound motor allows of advantage being taken of all these benefits without having recourse to motor generator sets, which are complicated, heavy, troublesome and waste a portion of the energy recovered. It will, of course, easily be appreciated that this is not the least of its advantages.

It does not permit of braking to a standstill, but by means of a simple series-parallel arrangement it is possible to obtain braking down to at least 1/5th of the maximum running speed; for example, down to 25 km. an hour for a rake running at 125 km. an hour.

Needless to say, from 25 km. an hour to a standstill, the stop can be effected without difficulty by means of compressed air or better still by rheostatic braking. In fact, by virtue of its shunt excitation fed directly from the line, the compound motor allows of the use of rheostatic braking under very much better conditions than does the series motor.

To conclude these interpolations I would state the following : At the present time, judging by definite and absolutely incontrovertible results, the compound motor *alone* should be employed in all applications of direct current electric traction, for light and heavy traffic and on all lines, however graded.

The use of the compound motor for direct-current electric traction must be seriously considered, for the trials carried out to date indicate clearly that in comparison with the series motor its use would give the following results :

—an increase in the overall speed and greater safety in braking;

— a considerable simplification of the control equipment and a more flexible speed control;

—an important reduction in the wear of brake shoes and of tyres;

— finally, regeneration of energy on down gradients and when stopping, without the use of motor generators.

As regards the summaries, I agree that Summary 33 should remain as it is; as for Summary 34, I propose the following wording :

« The systems on trial which embody compound motors on direct-current lines and provide regenerative braking down to low speeds can be of appreciable use on services with frequent stops. »

The President (in German). — Firstly, we must settle Summary 33, or, perhaps, combine it with 34.

Mr. Bachellery (in French). — I should like to reply to an observation made just now by Mr. Bacqueyrisse. I do not wish to enter into a comparison of compound and series motors, but Mr. Bacqueyrisse has quoted a figure I gave, stating that on a 1 in 30 gradient a train running at 90 km. (56 miles) an hour on the level would have its speed reduced to 45 km. (28 miles) an hour. This remark, which must be considered as applying to a given train hauled by a given locomotive, contains nothing detrimental to the series motor.

On account of temperature considerations, an electric motor, whether compound or series, has a maximum power which must not be exceeded. In consequence, the locomotive driven by this motor, when approaching this maximum power, can in no case haul the same load on a 1 in 30 gradient at the same speed as on the level.

Mr. Fairburn. — I should like to pro-

pose that the wording given by Mr. Graff-Baker be adopted for this Summary.

The President (in German). — Here is the wording :

« Systems of regenerative braking at present in service, since they do not operate down to low speeds, are of value only on lines having long heavy gradients ».

Mr. Parodi (in French). — It is the same wording as before. Why not put « certain speeds. »

Mr. Chantrell (in French). — We could say « ... operate only above certain speeds. »

The President (in German). — The wording then would be as follows :

« Present systems of regenerative braking are of value only on lines having long heavy gradients, since they operate only above certain speeds ».

— *This summary was adopted as the new No. 24.*

Mr. Fairburn. — *Summary 34 :*

34. Systems on trial on direct-curent lines which operate down to low speeds and can be used in normal train stops may prove of considerable value in suburban service.

The President (in German). — Has anyone any observations to offer?

Mr. Parodi (in French). — I am entirely in agreement with the wording of Summary 34, except as regards the final portion. There is no doubt that there are a large number of regenerative systems which work well, and are also well known. The compound motor is already on old idea. Mr. Bacqueyrisse has had the happy idea of reintroducing it on tramways. There are other systems and I do not think we should set ourselves a limit or state that one motor is better than the other : that depends on the circumstances.

With this exception I think we should keep the whole of the first part of the wording and merely amend the last part.

The complete text would be as follows:

« Systems on trial on direct-current lines which operate down to low speeds and can be used for normal train stops may prove of considerable value because they reduce the consumption of energy in services with frequent stops. »

The President (in German). — Are we agreed on this wording?

— *This text was adopted as the new No. 25.*

Mr. Fairburn. — *Summary 35 :*

35. In suitable cases, the question of awarding bonuses to train drivers on the basis of energy used might be investigated.

Mr. Cardon (in French). — Summary 35 does not appear to me to agree entirely with the facts.

About 10 years ago we introduced, on the Paris-Orléans, bonuses for saving electrical energy, calculated from statistical returns drawn up for that purpose.

Under approximately identical conditions, both as regards train speed and the apportionment of tonne-kilometres between the different classes of trains (the only variation being a slight increase in the average train tonnage), these bonuses have obtained for us a reduction per hundred tonne-kilometres recorded on the locomotive meters of the order of 20 %, which is an appreciable saving and one worth quoting.

I would mention that, of course, on

)onuses are divided into two sections, ne for saving energy, and one for punc- ual running. Now, we found when we nstituted energy-saving bonuses that on ccount of the method of allocation the ffect on the staff was to incite the dri- ers to save electrical energy at the ex- ense of punctuality; on several occa- ions we have even had to raise the bonus or keeping to time in order to obtain unctual train running, whatever might e the anxiety to save energy. There is lways a necessity for maintaining some uch balance in all these types of bonus chemes.

I suggest amending the wording of ummary 35, and saying : « It is of va- ue to award bonuses for energy saving o train drivers. This practice has been dopted by some Companies for several ears past ».

Mr. Parodi (in French). — I should ke to elaborate some of these statements n order to complete the information gi- en by Mr. Cardon.

When we introduced the system in uestion on the Paris-Orléans, we fitted att-hour meters and not ampere-hour eters, and we connected these watt-hour eters in the traction circuit alone; i.e. e only measured the traction motor nergy consumption.

The economies just mentioned by Mr. ardon are thus effectively achieved on e running of the trains, and not by tting off the heating, stopping the ven- lation fans or doing anything else of e same nature; they are savings effect- l on the traction supply proper.

The President (in German). — I think would be as well to take into consider- ion the remarks made and say that our commendation is to supplement the system of bonuses for energy saving by bonuses for punctual working.

Mr. Cardon (in French). — I quite agree. It is absolutely necessary to combine the two bonus systems. If this is not done one of the constituents of operation is bound to be sacrificed to the other.

Mr. Chantrell (in French). — We could say then :

« ... of awarding bonuses for economical consumption of energy in conjunction with awards for punctuality. »

Mr. Bacqueyrisse (in French). — I agree with this proposal, the more so that for some thirty years I have had watt-hour meters installed on the tramways, where the consumption varies considerably with the drivers and an economy of 20 % is easily obtained when meters are fitted.

But I should like to point out to the Members of this Assembly that though this installation is of interest with series motors, it is less so with compound motors — I omitted to mention this advantage just now — in that with the latter the equipment is much less sensitive to the driver's method of working, so much so, in fact, that on my System I have removed the meters from the coaches equipped with compound motors.

While I have the opportunity, I would like to make a few remarks to supplement those offered by Mr. Bachellery.

As a matter of fact, running up gradients at high speeds is a question of motor power, and the famous Capvern Bank I mentioned just now could be climbed at 90 km. (56 miles) an hour, but, when the series motor equipment designed for high speed on up gradients came to operate on the level, the series

motor would have to work in series with a resistance, which would be unnecessary with the compound motor on account of its self-regulating characteristic.

Mr. Parodi (in French). — I quite agree with Mr. Bacqueyrisse on the advantages of the compound motor. However, without wishing to re-open the controversy, I would say that it does not constitute the only means by which these results may be attained.

The President (in German). — I do not propose to go into too great details. I think we should agree on a suitable wording for Summary 35. We might say :

« In suitable cases, the question of awarding bonuses to train drivers, for economical consumption of energy by the driving motors, might be considered, provided these are combined with awards for observation of the schedule. »

Do you agree with this wording?

Mr. Parodi (in French). — I would prefer to put « ... with awards for punctuality ».

The President (in German). — The wording would then be :

« In suitable cases, the question of awarding bonuses to train drivers, for economical consumption of energy by the driving motors, might be considered, providing these are combined with awards for punctuality. »

Are we all in agreement?

— *The latter wording was adopted and became the new summary No. 26.*

The President (in German). — Gentlemen, we have now finished our examination of Question VI, and our business is completed. Has anyone any further observations to offer?

Mr. Fairburn. — On behalf of the Reporters, I should like to thank Dr. Wechmann for his very excellent Chairmanship. I must also express our thanks to the interpreters and in particular to Mr Velleman for the most competent manner in which he has carried out a very difficult task.

The President (in German). — In return I should like to express our gratitude to the Reporters, and particularly to the Special Reporter, for their very valuable contributions to the work of the Congress. *(Loud applause.)*

— The Meeting ended at 12.30 p.m.

DISCUSSION AT THE PLENARY MEETING.

Meeting held on 11th June, 1937.

Mr. LE BESNERAIS, Vice President, in the Chair.
General Secretaries : Messrs. P. GHILAIN, de BOYSSON and CAMBOURNAC.
Assistant General Secretaries : Sir H. Nigel GRESLEY and Dr. Th. KITTEL.

Mr. Ghilain, *General Secretary*. — We will now examine the Summaries relative to Question VI, which have been published in numbers 6 and 7 of the *Daily Journal of the Session*.

— *The examination of these summaries called forth no further comments.*

The President. — We shall, therefore take the summaries of Question VI as agreed.

Summaries.

« 1. Proposals for saving current cannot be considered on purely technical grounds, but must be related to the total cost to the railway, of the service performed.

« 2. In addition to the savings due to improvements in the equipment, which cannot be expected to make a great difference in the total energy consumption, direct savings in the energy required and in the recovery of energy by regenerative braking demand serious consideration.

« 3. The most important contribution of recent years to the improvement of electric traction equipment is the mercury vapour converter.

« This type of equipment has not yet reached its full development; it is however possible to predict that, in the near future, this development will reach « a point where the mutator will replace « the rotary converter in the same measure as the rectifier at present replaces the rotary converter for the conversion of alternating current to direct current.

« 4. The mercury vapour inverter has proved satisfactory on one Administration for reconverting direct to alternating current in the substations of direct-current lines employing regenerative braking. This will no doubt induce other Administrations with direct-current systems to seek further improvements in the same direction.

« 5. The fixed frequency ratio mutator has given satisfaction for the conversion of three-phase current to single-phase current of low frequency (Reichsbahn).

« Several types of mutators of variable frequency ratio have been tried. It cannot, however, be predicted yet which of these systems will eventually give satisfaction.

« 6. Grid control equipment is an inherent part of the mercury vapour converter for all uses except as a rectifier. In addition to its main function the equipment can also be adopted for all types of mutators to control the output voltage and to interrupt the main arc.

« 7. In cases where ripples in the out-

« put of a mutator cause interference in « communication or signal circuits, the « provision of resonant shunt filters « provides a satisfactory solution.

« 8. The water-cooled steel tank type « unit is the most widely used, but the « glass bulb type, and also the newly « developed low-capacity air-cooled type « form useful alternatives for some ap- « plications.

« 9. The substations should be situated « at sufficiently short intervals to ensure « a low voltage drop in the contact « system, although only the minimum of « copper and other materials is used in « the construction of the contact system « itself and in the substations.

« 10. On alternating-current lines this « can be effected by the introduction « between substations of intermediate « feed points provided with a simple « transformer controlled either from the « nearest railway station or by a remote « control system.

« 11. On direct-current lines the same « results can be obtained by the use of « remote-controlled single-unit rectifier « substations.

« 12. The additional cost of remote « control as compared with completely « automatic control is normally justified « by the increased flexibility given to « the system.

« 13. The mobile substation can some- « times be used with advantage to meet « temporary operating needs.

« 14. On alternating-current lines oper- « ating at high voltage the contact system « losses are readily reduced to a reason- « able value and any special steps are « usually needed to prevent communica- « tion circuit interference rather than to « save current.

« 15. On direct-current systems the « losses are higher, and special consi- « deration must be given to the question « of securing a reduction. Apart from « increasing the conductor section, these « include improved bonding of tracks « and contact circuits.

« 16. The weight of electric locomo- « tives for equal horse-power and trac « tive effort has been considerably re « duced during the last few years.

« 17. Weight reduction, particularly on « motor coach stock, is the most impor « tant means of saving energy. This ma « be attained by changes in constructio « and by the use of special materials « Changes in construction include th « combination of the body with the un « derframe and the use of welding, whi « special materials may be divided int « light alloys and high-tensile steels.

« 18. For high-speed trains the stream « lined form has a large influence o « the consumption of energy.

« The maximum result will be obtai « ed from the complete streamlining « the whole train set.

« 19. Roller bearings are used as mu « to reduce lubrication and maintenan « costs as to save energy; in consequen « they are found more widely on mot « coaches than on locomotives, and ha « been applied to motor armatures mo « frequently than to the locomotive « train axle journals.

« 20. Electric heating of vehicles « normally adopted on most electrifi « systems, the steam heating appara « being maintained. Fuel-fired boil « are used only in the case of vehic « drawn by both steam and electric « comotives, but they cannot be regar « as a means of saving energy.

« 21. The fitting of thermostats

« electric heating systems often leads to « considerable energy savings.

« 22. The use of a single electric heater « in conjunction with a system of hot « air ducts in each coach may be more « economical than the fitting of a num- « ber of electric radiators, taking into « account the time required for pre- « heating, the ventilation realised, and « the lightening of the vehicles.

« 23. In winter, the peak load of ener- « gy can be reduced by cutting out the « heating system when accelerating or « ascending heavy gradients or during « the periods of heaviest traffic.

« 24. Present systems of regenerative « braking are of value only on lines hav- « ing long heavy gradients, since they « operate only above certain speeds.

« 25. Systems on trial on direct-cur- « rent lines which operate down to low « speeds and can be used for normal « train stops may prove of considerable « value because they reduce the con- « sumption of energy in services with « frequent stops.

« 26. In suitable cases, the question « of awarding bonuses to train drivers, « for economical consumption of energy « by the driving motors, might be con- « sidered, providing these are combined « with awards for punctuality. »

[621. 131.3 & 625. 2]

A method of testing the appliances used for reducing air resistance on locomotives and other railway vehicles,

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(Revue générale des chemins de fer).

The increase in the average speeds of passenger trains, which French and foreign railways are being more and more compelled to adopt, has led railway engineers to study, amongst other problems, the reduction of the air resistance which forms an important fraction of the resistance at high speeds (1), and to design streamlined shapes for locomotives and vehicles.

The procedure followed in such work is generally as follows :

(1) Different arrangements (streamlined casings, deflector plates, etc.) are fitted on various locomotive or vehicle models of reduced scale, and resistance tests carried out in a wind tunnel.

These tests enable the different arrangements tried to be classified according to their streamline value, and a coefficient of value awarded to each of them.

(2) The arrangement, or arrangements, which are shewn to be the most efficient are then fitted on locomotives or vehicles, and running trials carried out on the line with a view to *measuring* the effective gain in power.

As a matter of fact, with the measurements made in tunnel tests with models of reduced size, it is very difficult to establish, with any precision, the values of the air resistance of the full-sized vehicle.

This lack of precision is, moreover, accentuated by the fact that the conditions are not identical in the two cases. On the one hand, it is very difficult to reproduce on models the movements of the wheels, rods and various motion parts, the influence of which from the point of view of air resistance cannot be ignored as negligible. This has never been accomplished in tunnel tests so far as our knowledge goes. On the other hand, it is impossible to reproduce in the tunnel the movement of the locomotive in relation to the fixed earth. The artifices used to imitate such conditions (locomotives arranged symmetrically) do not appear capable of giving complete satisfaction, and therefore the comparative results obtained from the use of models without being solely qualitative, are hardly capable of giving them anything more than approximate coefficients or « comparative values ».

The French Est Railways, which undertook the design of various streamline arrangements in accordance with the procedure set out above, had, in particu-

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(1) Trials carried out by the French Est Railways in 1934 and 1935, by comparing the power at the drawbar hook of a 4-8-2 locomotive, measured (1) on the Vitry locomotive test bed, and (2) on the line, shewed that the power absorbed by air resistance could, at 120 km. (75 miles) an hour, exceed 400 H.P. (the total horse-power at the tread reaching 2 700 in continuous working.)

o find a solution of the problem of *the measurement, on the road, of the power increase resulting from the use of an arrangement of this kind* (1).

Problem to be solved. — Difficulties.

This problem is a very delicate one. First of all in practice the value of the air resistance for a given vehicle, at a given speed, depends on the contour of the ground (cuttings, obstacles, etc.), the velocity of the wind, the direction of the wind, the atmospheric pressure, and the temperature.

The measurements which can be taken on a vehicle running at a certain speed will therefore only be applicable for a given value of each of the other factors, namely : *atmospheric pressure, temperature, velocity and direction of the wind, nature of the ground.*

It is therefore advisable, in presenting the results, to give precise values for the different accompanying factors. Moreover, it is interesting, from the practical point of view, to calculate the averages of different trials carried out under normal atmospheric conditions.

With this in mind, let us see what the problem is like in the case, for example, of the trial of an arrangement such as the streamlined casing fitted on a locomotive.

Theoretically, to determine exactly the influence of the arrangement under given speed and other conditions, all that is necessary is to measure, under these conditions, by means of the dynamometer car, the power developed at the draw-bar hook by the locomotive with and then without the streamlined arrangement. The difference, of course, represents the gain resulting from the streamlined arrangement.

In practice, the length of line used for the trial, and then the work of fitting (or dismantling) the arrangement to be tried take a certain time, generally at least one day, and the atmospheric conditions may in the meantime vary very considerably. The error caused thereby may constitute a large fraction of the value to be measured.

In order to avoid this disadvantage, first of all care was taken to compare the power developed on the same sections of line, first by the locomotive fitted with the arrangement under trial and then by an identical locomotive not so fitted, following it at a short distance, which would enable the influence of the variation in the accompanying factors to be practically eliminated.

This introduces new errors, however, owing to the difference in the mechanical resistances of the locomotives and the characteristics of their driving mechanisms, an error which, there again, may be almost as much as the differences in the powers to be measured, even for two locomotives of the same class, which are considered to be theoretically identical.

This therefore led to the adoption of a third solution which is described below, and which entails the use of a locomotive (or train) for comparative purposes, but only brings into play the outside shape of such a locomotive.

Principle of the method adopted.

We will take a locomotive as an example throughout, the method remaining the same if this locomotive had vehicles attached to it.

The measurements taken are as follows :

(1) On the same section of line, at the same speed and at a few minutes' inter-

(1) This measurement makes it possible, in particular, to verify if the gain in power, and consequently the economies resulting from such and such an arrangement, justify the initial expenditure, and the subsequent and consequent extra maintenance costs.

val, measurements are taken of the power developed at the drawbar hook :

a) By the test locomotive before modification (we shall call this « L_A »), and for properly determined running conditions (pressures, degrees of cut-off) ;

b) By a comparative locomotive « C », as identical as possible to « L_A » as regards the outside arrangements and dimensions, with running conditions appreciably the same as the foregoing conditions, and properly determined.

Let P_A and P_C represent the powers ascertained at the drawbar hook of the two locomotives on a determined stretch of track MN.

(2) The locomotive L_A is fitted with the arrangement to be tried and becomes L_B.

A second series of trials is then carried out on another day at the same speed and on the same line, with the locomotives L_B and C following one another at a few minutes interval, and maintaining for each of them the running conditions (pressure, cut-off, etc.) as obtained for the first series of trials.

Let P'_B and P'_C represent the powers at the drawbar hook of the two locomotives on the same stretch of line MN.

The difference $P'_C - P_C$ represents, with trial errors excepted (1), the power variation resulting, for the comparative locomotive, from the variations in the atmospheric conditions on the first day of the trial and on the other day.

If we admit that, for a given speed and given accompanying conditions, the air resistance is the same on the locomotives L_A and C, which are identical on the outside, it will be seen that if the locomotive L_A had been tried on the second day, it would have given a power of :

$$P_A + P'_C - P_C \quad (2)$$

It is this corrected power which is to be compared with the effort P'_B of the locomotive L_B, and the difference

$$P'_B - P_A - (P'_C - P_C)$$

measures the power increase at the drawbar hook resulting from the arrangement tried *over the stretch of line considered and for the atmospheric conditions which prevailed on the second day of the trial.*

Practical realisation.

Measurements based on this method have been carried out by the French Est Railways on the Gretz-Troyes section (120 km. = 75 miles) at a constant speed of 110 km. (68.3 miles) an hour.

The maintenance at constant values of the speed and of the running conditions was realised by using what is known as the « Polish » method, the principle of which has been described in several articles in the *Revue Générale* (1).

The trial trains hauled, one by the trial locomotive and the other by the comparative locomotive, were composed of a dynamometer car and a brake locomotive. The trains followed one another at an interval of ten minutes.

In actual fact, instead of the 2 series of trials which had been arranged for each measurement, 3 series were carried out, the trial locomotive having successively been used for comparative purposes against the comparative locomotive, as follows :

a) In its initial condition;

b) After modification;

c) Again in its initial condition.

(1) This supposes that the characteristics of the driving mechanisms and the mechanical resistances for the different locomotives remained the same. This is practically correct if the whole of the trials is carried out within a sufficiently short space of time.

(1) See *Bulletin of the Railway Congress* July 1931, p. 575.

This last check enabled an idea to be obtained of the degree of approximation to be expected from the method (1) : the differences found are less than 2 % of the power measured.

We give below some figures of the results obtained in the course of the first application of this method, which application enabled it to be improved. The trial concerned an apparatus known as a « deflector », put forward by Mr. Huet. We will describe this first trial to illustrate the method in question, as this is the method we intend to use in connection with the design of various streamline casings now being fitted on models and after comparing these models in the tunnel.

An example of the practical application of the new test method. Determination of the power economy obtained by the Huet deflector.

The Huet deflector, which is shewn in figure 1 as fitted on the locomotive, consists essentially of a certain number of divergent adjutages made of steel plate, arranged in front and at the sides of the locomotive, in such a manner as to canalize the air and form a sort of fluid streamline casing round the locomotive.

This arrangement evidently possesses very great advantages over the completely enclosed streamline casings made of steel plate, from the point of view of weight, price, and accessibility of the parts, and it was interesting to compare its results in actual working.

The results of the measurements given below constitute the first element of the comparison. They make it possible, in addition, to estimate the resistance of the side smoke deflector plates.

The comparative locomotive was No. 230.234, fitted with side smoke deflector plates of the ordinary type.

The trial locomotive was No. 230.268 which was tested successively with the following arrangements :

A. — Without deflector and without side smoke deflector plates;

B. — Without deflector, with side smoke deflector plates (identical with the comparative locomotive);

C. — With deflector, and without side smoke deflector plates;

D. — With deflector, and with side smoke deflector plates.

Conditions under which the tests were carried out.

The power at the drawbar hook was measured for each trial train by means of a dynamometer car which had been calibrated beforehand (1) (Central Rolling stock Designs Office dynamometer car No. 1 for the trial locomotive No. 230.268, and French Est Railways dynamometer car No. 2 for the comparative locomotive No. 230.234).

On each of the two locomotives Nos. 230.268 and 230.234, the running conditions were maintained as constant as possible during the tests, namely : H. P. and L. P. admissions, adjustment of blast pipe

(1) The differences in the powers between the trial locomotive and the comparative locomotive, taken on the one hand during the course of the trials *(a)*, and on the other hand during the course of the trials *(c)*, are the result of measuring errors, or of variations in the characteristics or in the mechanical resistances of the locomotives.

(1) It should be noted that the method used also eliminates the errors which might arise from a defect in the calibration of the dynamometers. It is enough, for the results to remain exact, that there shall be no error with regard to the difference in the efforts measured by each dynamometer during the trials.

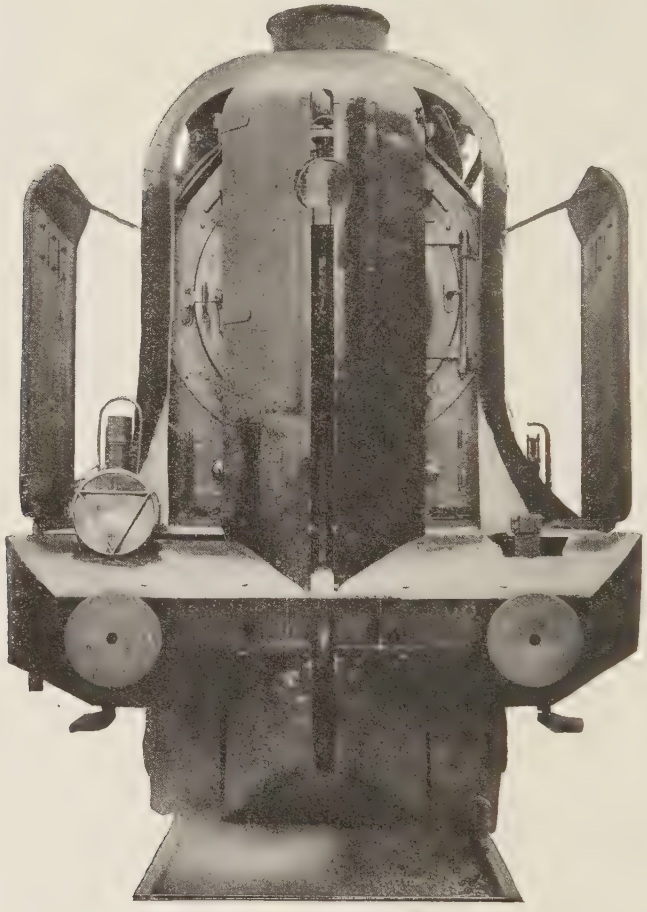


Fig. 1. — Front view of locomotive fitted with Huet deflector.

opening, and pressures in the steam chests.

The tests were carried out at a speed of 110 km. (68.3 miles) an hour.

During each test, at the end of the outward trip and also of the return trip, a record was made of the velocity and direction of the wind, the temperature, and the barometric pressure (this information will be found in the tables Nos. to 4 in figure 2).

Results obtained.

The figures obtained from the dyn mometer car records for the two tr trains yielded the following gross sults :

	Particulars obtained rom the dynamometer car records for locomotive No. 230.268.							
	In condition A. (Without deflector and without side plates).		In condition B. (With side plates only).		In condition C. (With deflector only).		In conditfon D. (With side plates and with deflector).	
	Power recorded. A =	Average speed realised, km.(*miles*)	Power recorded. B =	Average speed realised, km.(*miles*)	Power recorded. C =	Average speed realised, km,(*miles*)	Power recorded. D =	Average speed realised, km.(*miles*)
Outward trip.	773 H.P.	106.8 (*66.4*)	761 H.P.	109.3 (*67.9*)	810 H.P.	108.4 (*67.3*)	820 H.P.	107.8 (*67.0*)
Return trip.	798 H.P.	109.4 (*68.0*)	776 H.P.	110.0 (*68.35*)	826 H.P.	110.1 (*68.9*)	776 H.P.	108.5 (*67.4*)
	Particulars obtained from the corresponding dynamometer car records for locomotive No. 230.234.							
	A' =		B' =		C' =		D' =	
Outward trip.	842 H.P.	110.6 (*68.7*)	879 H.P.	111.3 (*69.2*)	853 H.P.	111.7 (*69.4*)	810 H.P.	110.6 (*68.7*)
Return trip.	880 H.P.	111.1 (*69.0*)	884 H.P.	110.7 (*68.8*)	855 H.P.	110.5 (*68.6*)	808 H.P.	109.8 (*68.1*)

It will be seen that it was not possible exactly to maintain the speed at 110 km. (68.3 miles) an hour in spite of the use of brake locomotives. This was caused to some extent by the very variable profile of the trial length of line.

As the figures recorded for the powers are not, for this reason, perfectly comparable, a correction has had to be made.

This correction has been made graphically. Special trials made enabled measurements to be taken for each of the two locomotives, and always with the same cut-off conditions and the same tractive efforts at different speeds, and consequently it was possible to plot the curves of the efforts in terms of the speed. We easily deduced from these for each test run — admitting the same law of variation, and starting from the effort shewn at the indicated speed — the effort at the speed of 110 km. an hour, and then the power at the same speed. We thus obtained the figures set out in the following table :

	Powers developed at the speed of 110 km. (68.3 miles) an hour.							
	By locomotive 230.268 without deflector and without side plates. A	By comparative locomotive 230.234. A′	By locomotive 230.268 with side plates only. B	By comparative locomotive 230.234. B′	By locomotive 230.268 with deflector only. C	By comparative locomotive 230.234. C′	By locomotive 230.268 with deflector and side plates. D	By comparative locomotive 230.234. D′
Outward	762	844	758	886	806	862	813	813
Return	796	885	776	887	826	858	769	807

Fig. 2. — Tables 1 to 4, giving the results obtained with the different combinations tried.

Powers measured at the drawbar hook, between Gretz and Troyes, at a speed of 110 km. (68.3 miles) an hour for various conditions of the trial locomotive.

Condition A : *Without deflector and without side plates.*
Condition B : *Without deflector, with side plates.*
Condition C : *With deflector, without side plates.*
Condition D : *With deflector and with side plates.*

Note. — The comparative locomotive (columns A', B', C', D') had side plates, but no deflector.

Kilometric points of the test sections.		Atmospheric conditions for day J'.		Powers obtained at the drawbar hook (H.P.				Di e C I
		direction of trial section ⟹ in relation to the direction of the wind ⟶ and speed of the wind in m./sec.	Temperature. Barometric pressure. State of the weather.	on the trial locomotive.	on the comparative locomotive.	on the trial locomotive.	on the comparative locomotive.	
Start.	Finish.			On day J.		On day J'.		
		(1) *Influence of the side plates.*		Condition A. J = 14/2/36.		Condition B. J' = 17/2/36.		(B —(I
				A	A'	B	B'	
Outward.								
50	77	1m70	Temperature : at start : 8° C. (46.4° F.). on arrival : 9° C. (48.2° F.).	742	814	742	842	—
78	95		Barometric pressure : at start : 749 mm. (29.49"). on arrival : 751 mm. (29.57").	777	878	754	921	—
97	138		Weather : at start : misty. on arrival : fine.	766	835	763	894	—
138	155			775	877	775	889	—
		Averages for the outward trip . .		762	844	758	886	—
				J = 15/2/36.		J' = 18/2/36.		
Return.								
155	138	3m10	Temperature : at start : + 8° C. (46.4° F.). on arrival : + 9° C. (48.2° F.)	792	892	803	883	+
138	97		Barometric pressure : at start : 748 mm. (29.45"). on arrival : 747 mm. (29.41").	781	864	750	861	—
77	50		Weather : at start : misty. on arrival : rainy.	820	901	798	928	—
		Average for the return trip . . .		796	885	776	887	—

metric ints e test ions.	Finish.	Atmospheric conditions for day J'.		Powers obtained at the drawbar hook (H.P.).				
		direction of trial section → in relation to the direction of the wind → and speed of the wind in m./sec.	Temperature. Barometric pressure. State of the weather.	on the trial locomotive. (On day J.)	on the comparative locomotive. (On day J.)	on the trial locomotive. (On day J'.)	on the comparative locomotive. (On day J'.)	Difference. Gain + Loss —
		2) *Effect of the deflector on a locomotive without side plates.*		Condition A. J = 14/2/36.		Condition C. J' = 20/2/36.		
				A	A'	C	C'	(C—A) —(C'—A')
rd trip.		0m90	Temperature : at start : + 9° C. (48.2° F.). on arrival : + 11° C. (51.8° F.). Barometric pressure : at start : 762 mm. (30"). on arrival : 760 mm. (29.92"). Weather : at start : fine. on arrival : fine.					
	77			742	814	794	833	+ 33
	95			777	878	825	908	+ 18
	138			766	835	(*a*	881	(*a*)
	155			775	877	(*a*)	926	(*a*)
		Averages for the outward trip . .		762	844	806	862	+ 26
turn.				J = 15/2/36.		J' = 21/2/36.		
	138	2m70	Temperature : at start : 0° C. (32° F.). on arrival : + 6° C. (42.8° F.) Barometric pressure : at start : 758 mm. (29.84"). on arrival : 758 mm. (29.84"). Weather : at start : fine. on arrival : rainy.	792	892	813	877	+ 36
	97			781	864	821	814	+ 90
	50			820	901	843	891	+ 33
		Averages for the return trip . . .		796	885	826	858	+ 57
		(3) *Effect of the deflector on a locomotive with side plates.*		Condition B. J = 17/2/36.		Condition D. J' = 12/2/36.		
rd trip.				B	B'	D	D'	(D—B) —(D'—B)'
	77	0m75	Temperature : at start : + 6° C. (42.8° F.). on arrival : + 8° C. (46.4° F.). Barometric pressure : at start : 762 mm. (30"). on arrival : 763 mm. (30.04"). Weather : at start : fine. on arrival : fine.	742	842	790	791	+ 99
	95			754	921	811	834	+144
	138			763	894	816	820	+127
	155			775	889	846	810	+150
		Averages for the outward trip . .		758	886	813	813	+128

Test cancelled, boiler regulator being out of order.

Kilometric points of the test sections.		Atmospheric conditions for day J'.		Powers obtained at the drawbar hook (H.P.				
		direction of trial section ⟹ in relation to the direction of the wind ⟶ and speed of the wind in m./sec.	Temperature. Barometric pressure. State of the weather.	on the trial locomotive.	on the comparative locomotive.	on the trial locomotive.	on the comparative locomotive.	Di er G L
Start.	Finish.			On day J.		On day J'.		
Return.				J = 18/2/36.		J' = 13/2/36.		
155	138	0m63	Temperature: at start: 0° C. (32° F.), on arrival: + 3° C. (37.4° F.)	803	883	777	793	+
138	97		Barometric pressure: at start: 763 mm. (30.04"), on arrival: 765 mm. (30.12").	750	861	759	799	+
77	50		Weather: at start: misty, on arrival: fine.	798	928	783	827	+
		Averages for the return trip . . .		776	887	769	807	+
		(4) *Effect of side plates and deflector combined.*		Condition A. J = 14/2/36.		Condition D. J' = 12/2/36.		
Outward trip.				A	A'	D	D'	(D —(I
50	77	0m75	Temperature: at start: + 6° C. (42.8° F.), on arrival: + 8° C. (46.4° F.)	742	814	790	791	+
78	95		Barometric pressure: at start: 762 mm. (30"), on arrival: 763 mm. (30.04").	777	878	811	834	+
97	138		Weather: at start: fine, on arrival: fine.	766	835	816	820	+
138	155			775	877	846	810	+
		Averages for the outward trip . .		762	844	813	813	-
Return.				J = 15/2/36.		J' = 13/2/36.		
155	138	0m63	Temperature: at start: 0° C. (32° F.), on arrival: + 3° C. (37.4° F.)	792	892	777	793	-
138	97		Barometric pressure: at start: 763 mm. (30.04"), on arrival: 765 mm. (30.12").	781	864	759	799	-
77	50		Weather: at start: misty, on arrival: fine.	820	901	783	827	-
		Averages for the return trip . . .		796	885	769	807	-

Examination of the results.

The foregoing results, obtained with ifferent combinations of streamline de-ices used successively, enabled the fol-owing deductions to be made :

1. *Influence of the side plates* (table 1 n figure 2) :

This is obtained by comparing the re-ults of the tests in the conditions A and 3, in accordance with the formula given bove, namely :

$$(B—A)—(B'—A') = \begin{cases} \text{on outward trip : } —46 \text{ H. P.} \\ \text{on return trip : } —22 \text{ H. P.} \end{cases}$$

As was to be expected, the economy is negative, because, as the side plates in-crease the principal resisting moment, hey cause a loss in power.

2. *Influence of the deflector on a loco-notive not fitted with side plate* (table 2 n figure 2).

This is obtained by comparing the rials A and C, namely :

$$(C—A)—(C'—A') = \begin{cases} \text{on outward trip : } 26 \text{ H. P.} \\ \text{on return trip : } 57 \text{ H. P.} \end{cases}$$

3. *Influence of the deflector on a loco-notive fitted with side plates* (table 3 in igure 2).

We obtained this by comparing the rials B and D, namely :

$$(D—B)—(D'—B') = \begin{cases} \text{on outward trip : } 128 \text{ H. P.} \\ \text{on return trip : } 73 \text{ H. P.} \end{cases}$$

4. *Influence of the whole, namely : ide plates and deflector* (table 4 in fi-gure 2).

This is obtained by comparing the rials A and D, namely :

$$(D—A)—(D'—A') = \begin{cases} \text{on outward trip : } 82 \text{ H. P.} \\ \text{on return trip : } 51 \text{ H. P.} \end{cases}$$

The tests carried out consequently enabled a sufficiently clear idea to be obtained of the efficiency of the arrangement.

In order to explain the differences in the figures of the power economies on the outward and return trips, for the trial with the deflector and the side plates, the velocity and direction of the wind on the day the arrangement was tested must be taken into account. As a matter of fact, a head wind increases the relative speed of the locomotive and the air, whilst a rear wind reduces it, and the deflector must obviously be all the more efficient as the relative speed is higher.

If, in particular, we consider that the test on the outward trip in the condition D (with deflector and side plates) was carried out with a wind which was almost head on (25°) blowing at 0.75 m. (2.46 ft.) per second, whilst the test on the return trip was carried out with a wind in the opposite direction blowing at 0.60 m. (1.97 ft.) per second, it will be seen that there is an explanation for the differences between the two measurements.

The tests also showed that the side plates, used by themselves, absorb power, whilst the power loss that they occasion when used in conjunction with the deflector is less marked, since the economy obtained by the use of the deflector is higher when it is fitted on a locomotive with side plates than on a locomotive without them.

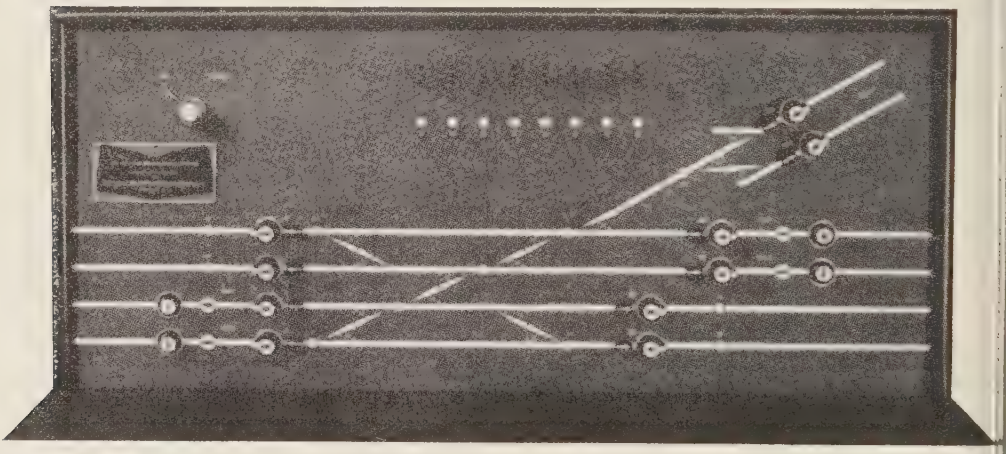
To sum up, the consistency of the results obtained shews that by endeavouring to maintain the running conditions constant throughout the whole series of tests, the method enables sufficiently accurate particulars to be obtained about the value of a given streamline arrangement. The relative error will obviously be the smaller the more efficient the streamline arrangement. From this point of view, the application given as an example could not be very favourable, as the deflector tried is only capable of giving a relatively limited effect.

[656. 258 (.73)]

New York Central installs first button-control route interlocking.

(Railway Age.)

On September 23, 1937, the New York Central placed in service at Girard Junction, near Erie, Pa., the first installation in America of a new type of interlocking control, in which the switches in a route and the signal for directing a train movement over that route are all controlled by the operation of a knob and a button on a track model which is a part of the control panel. The knob is located on the line representing the track at a point corresponding with the location of the signal where the train will enter the plant; hence it is called an entrance knob. The button is located at the point where the train is to leave the plant; hence it is called an exit button. Thus, the operator does not think of a route in terms of individual switch and signal levers, but rather as having an entrance and an exit. The control for a complete route, involving as many as four crossovers, two single switches and a derail, can be completed and the signal cleared in approximately nine seconds after the operator pushes the exit button. The advantages of such rapid operation in a busy terminal plant requiring numerous changes in routes are readily apparent.



New route type control machine.

Unit as compared with route control.

For many years, both in this country and abroad, some signal engineers have favored interlocking machines on which levers controlled one or more *interlocking units,* while others have favored machines where levers have controlled *routes.* In some European countries the route-lever system is w

idely used, but in the United States the control of interlocking units by levers predominates, chiefly because of greater simplificity, ease in correcting trouble, and further because in many track layouts more levers would be used for route control than for interlocking unit control. The new « NX » (route control) system is an entirely new conception. It is based on the theory that all routes have an entrance and exit. It combines the desirable features of the two systems, in that a route can be set up more rapidly and with fewer manipulations than in any interlocking system heretofore designed.

Location of plant.

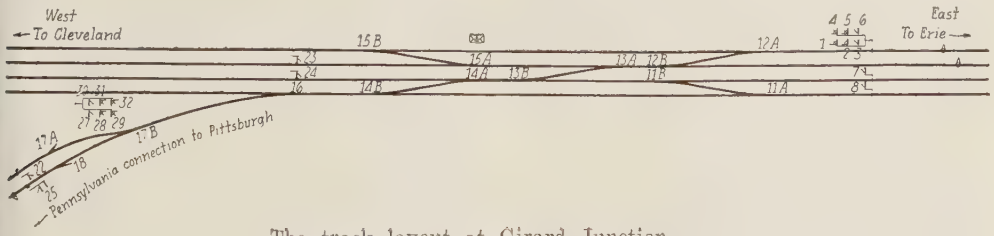
The new plant at Girard Junction is located on the New York-Chicago main line at a point 17 miles west of Erie, Pa. Throughout the Erie division, the New York Central has four main running tracks. At Girard Junction there is a junction between the New York Central and a single-track main line of the Pennsylvania, which extends south to Pittsburgh, Pa., via New Castle, Pa., the Pennsylvania using the New York Central tracks between Girard Junction and Erie. The average daily traffic through this plant includes about 50 passenger trains and 50 freight trains on the New York Central, and 2 passenger trains and 20 freight trains on the Pennsylvania. Extra passenger trains and freight trains are operated as required, so that the total train movements through Girard Junction average from 125 to 150 daily.

Changes made at this time.

The track layout at Girard Junction includes 5 crossovers between main tracks of the New York Central, 2 single switches, and 2 derails on the Pennsylvania, and a total of 10 signals. This plant was formerly controlled by a conventional lever-type electric interlocking machine with a 32-lever frame, including 30 working levers. This machine was one of the early pistol-grip type, and, as it had been in service at this busy plant since August 17, 1906, the parts were worn to the extent that replacement of the entire machine was necessary. The only change made in the 1937 improvement was to replace the old electric interlocking machine with the new control machine. The switch machines, signals, power battery, and all wiring distribution outside the tower were continued in service without change.

The control system and button-type machine installed at Girard Junction were designed and manufactured by the General Railway Signal Company, this company adopting the name NX as descriptive of its system of route control, the name being derived from the two words «entrance » and « exit ».

The new control machine is made up in the form of a cabinet, the control panel being 13 in. high and 29 in. long. The track model on the face of this panel represents all the track sections, switches, and signals in the interlocking. The white lines representing the track are 3/16 in. wide, and stand out in contrast with the dull black face of the



The track layout at Girard Junction.

panel. The switches and cross-overs are represented by small, movable sections of the track called route indicators, which outline the route immediately after the operator pushes an exit button. A small lamp with a red lens, mounted behind the track lines, is located adjacent to each movable route indicator, and each such lamp is lighted when its corresponding switch in the field is locked and not free to be moved. Thus these lamps are known as « lock lights ». Small track occupancy lamps, mounted in the section representing each track circuit, are normally extinguished, but are illuminated when a train occupies the corresponding track section.

In the line representing the track, at the location corresponding to each interlocking signal, there is an entrance knob. Each of these knobs is 3/4 in. in diameter and stands out 1 in. from the face of the panel. The knob is hollow and surrounds a separate support for a round disk of transluscent glass with a black arrow, which fits in the face of the knob. The arrow points in the direction in which the corresponding signal controls, and maintains this position regardless of whether the knob is turned. The lamp behind the arrow is illuminated when the route is complete and the signal clears. A small round white marker on the outer rim of the knob indicates its position, this marker normally being in line with the track and at the base of the arrow in the face of the knob. When lining up the route, the knob is turned to bring the white marker to the top when clearing a high-speed signal for a through-route or a medium-speed signal for a diverging route. The knob is turned to bring the white marker to the bottom when clearing a low-speed or call-on signal.

An exit button is mounted in the line representing each track at the place where the train leaves the controlled area. Each exit button is 9/16 in. in diameter, and normally stands out from the panel 5/16 in. A white arrow on the face of each button points in the direction a train is going when leaving the end of a route controlled by the respective button. When lining up a route, the exit button is pushed in and it then returns to its normal position by spring action. An annunciator system, including bells and indicator lights, informs the operator of the approach of trains.

Operation of machine.

When the operator is ready to line up a route through the interlocking for an approaching train, he turns the entrance knob corresponding to the point where the train is to enter the interlocking area. This is known as « route initiation ». Next, he pushes the exit button corresponding to the point where the train will leave the interlocking area. This is known as « route completion ». This operation completed, the system automatically lines up the route. First the route indicators, on the control panel, line up, showing the route that was called for; then the switches in the field operate into the positions required by the route. Next the signal clears in the field, and, on the control panel, the small red lock lights appear at the point of their associated route indicators, indicating those switches which are locked up. A light illuminates the arrow in the entrance knob, showing that the signal has cleared and that the route is ready. As the train accepts the signal and travels over the route, the track occupancy lamps on the panel in the route are illuminated to indicate the movement of the train. The light in the entrance knob is extinguished as the home signal goes to stop. As the train passes through the plant and the route is released, the small red lock lights disappear.

If the operator wishes to hold the route, he leaves the entrance knob in the same position, and the home signal automatically clears for a following train

If he wishes to set up a new route, he turns the entrance knob back to normal and lines up the new route in the usual way. The facility of holding the same route for a succession of trains has its value at Girard Junction, where there are numerous through movements on the New York Central main line. However, the system can be made to provide automatic route restoration by the train, in which case the operator *pushes* the entrance knob instead of turning it when lining up the route. Moreover, the option of manual or automatic route

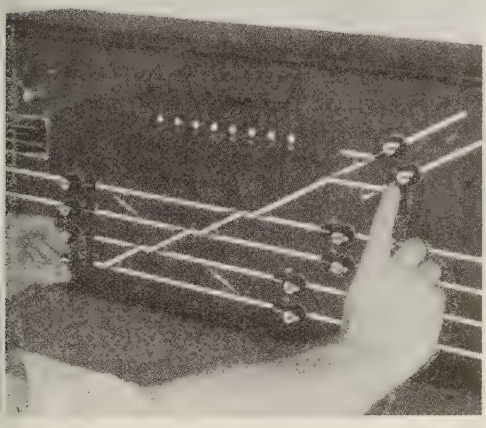


Illustration of the methods of machine operation.

restoration can be obtained with the one type of entrance knob and either or both may be used as operating conditions require.

Since the setting up of a route requires that the operator knows only the entrance and exit of a route, the operation of the plant is simple, no manipulation charts or diagrams being required. An important point is that an operator newly assigned to this plant can readily learn how to handle the control machine without an extended period of instruction.

With the new control machine, the Girard Junction plant can be operated much faster in changing routes than was formerly possible. With the conventional type of electric interlocking, when operating a switch, the lever was moved into the indication position and the operator then had to wait until the switch machine operated and locked up, at which time the indication lock on the lever was released to permit final movement of the lever. The total time required for the operation of each lever was from four to six seconds. In lining up a route involving several switches, the operator usually placed all the levers over to the indication point and then went back to each lever to complete its operation; therefore, the total time was somewhat less than six seconds multiplied by the number of levers operated. Each crossover, single switch, and derail was controlled by a separate switch lever. For example, when routing a train from track 3 on the New York Central to the passing track on the Pennsylvania, a total of 5 switch and derail levers and 1 signal lever were operated, requiring about 30 seconds of the operator's time to line up the route. In contrast, with the new NX system, the operator can line up this route in about nine seconds from the time he turns the entrance knob and pushes the exit button until all the switches in the route operate into correspondence and the signal clears. This means a saving of about 21 seconds in time for completing the route and clearing the signal. Thus, in an instance when two trains on close time are approaching the plant, a delay or a stop to one train or the other is frequently obviated by the NX control machine.

When maintaining and adjusting switch points and switch machines, it is desirable to have individual control rather than route control, which forms a part of the NX system. For this reason, a separate test key is provided for each

switch, these keys being mounted in a row along the top of the control panel. When in the center position, these keys are disassociated with, and have no effect on, the normal operation of the plant. When a maintainer wants to test a switch, however, the operator must first cancel any route set up over the switch and then manipulate the corresponding test key *down* to place the switch normal, and *up* for reverse. A small lamp below each test key is lighted whenever the key is moved into a position out of correspondence with the position of the switch in the field. This lamp stays lighted until the switch is over and locked in the position corresponding to that of the key. These small lamps also light whenever a switch is out of correspondence with the position called for by the route lined up on the control panel. Therefore, if the operator sees that one of these lamps remains illuminated, he knows that the switch has failed to complete its stroke and lock up. In addition to being used for test purposes, the test keys can be used at any time that a switch fails to operate properly in the normal procedure. For example, if the switch points are obstructed by snow, the operator can throw any switch back and forth by manipulating the test key, thereby smashing the obstruction and permitting the switch to complete its movement and lock up. He can then revert to the use of the normal control, which automatically cuts out the test key. An important point is that movement of the test keys is ineffective when any route is established by normal control, and that if a test key is operated, a route can be set up over its corresponding switch, but only in the position already called for by the test key.

First installation in America.

This installation at Girard Junction on the New York Central was the first installation of button-control route interlocking in the United States, although an installation of the same NX type of equipment, manufactured by the General Railway Signal Company, Limited, of London, England, was placed in service on the Cheshire Lines at Brunswick, England, on February 28, 1937, this being the first installation of its kind in the world.

The control of this NX type route interlocking system is accomplished by inter-connection of circuits, no mechanical locking between knobs and buttons and no electric lever locks being used. Complete protection is provided to insure that a route is properly established and that no conflicting route can be established. The circuits are arranged to provide approach, route and detector locking according to modern practices. The circuits are all of the direct-wire type, no coded equipment being involved.

The installation of the new interlocking control was carried out by the signal forces of the New York Central, under the jurisdiction of F. B. Wiegand, signal engineer, and under the supervision of H. D. Abernathy, assistant signal engineer, and L. L. Whitcomb, supervisor of signals. The major items of material for this interlocking, including the control machine and new relays, were furnished by the General Railway Signal Company.

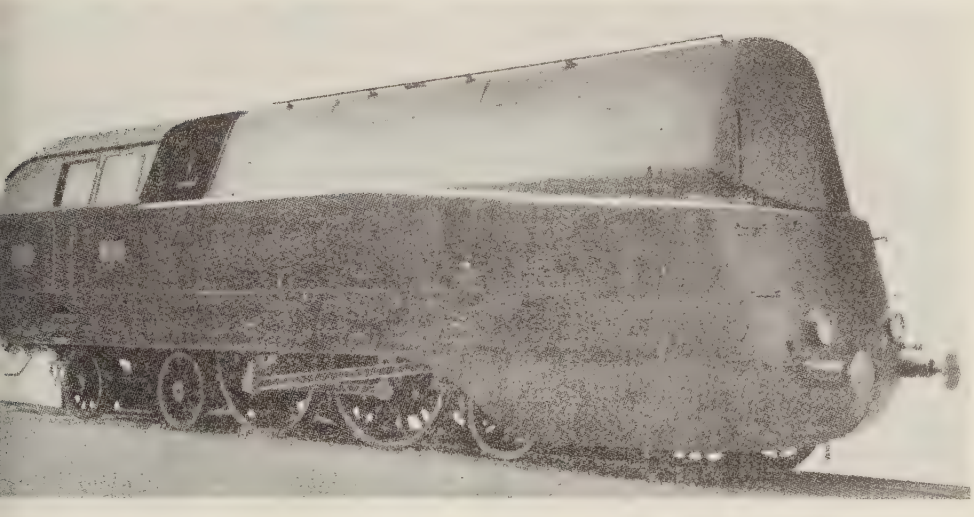
MISCELLANEOUS INFORMATION.

[621. 132.6 (.439)]

New streamlined 4-4-4 tank engine, Hungarian State Railways.

(Designed for high-speed service on relatively light permanent way.)

(The Railway Gazette.)



The locomotive illustrated was built at the Royal Hungarian State Iron Works, Budapest, from designs prepared by the Chief Mechanical Engineer of the Hungarian State Railways, the Hon. Cornelius Laner de Orova, for the purpose of working an accelerated service of four- or five-coach trains between Budapest and some of the more distant country towns in Hungary. The permanent way on certain of the sections worked over is laid with fairly light rails, so that it was necessary to restrict the weight of the locomotive as far as possible without impairing its capacity. Of the 85.3 tons which represent the loaded weight of the engine, less than 15 tons rest on each coupled axle. The table below gives particulars of the performance of the engine on different grades with varying train loads :

Speed (m.p.h.)	Level to 1 in 330	Grade 1 in 330 to 200	Grade 1 in 200 to 173	Grade 1 in 173 to 125
	Weight of trains (tons).			
75	167	162	157	138
68	207	197	187	167
62	241	231	217	197
56	325	310	285	236

There are two outside cylinders, driving the second pair of coupled wheels; steam distribution is by inside admission piston valves actuated by Walschaerts gear. The leading and trailing 4-wheeled bogies have a lateral play in each direction of 2 3/4 in., controlled by springs. All the wheels are acted upon by Knorr air brakes, with a brake cylinder pressure for a speed of 44 m.p.h. of 97 lb. per sq. in., and 34 lb. per sq. in. for lower speeds, automatically adjusted by a centrifugal regulator. At speeds over 44 m.p.h., 50 per cent of the weight on the leading bogie is braked, 180 per cent. of the weight on the coupled wheels, and 120 per cent. of the weight on the rear bogie wheels. At 75 m.p.h., the indicated capacity of the locomotive is 740 H.P., and this can be increased temporarily to 900 H.P. It is calculated that about 10 per cent. of this output is due to the fact that the engine is streamlined. Under test the engine ran quite smoothly at speeds of 95 to 100 m.p.h, and it has also proved its ability to maintain a speed of 75 m.p.h under regular service conditions.

Since May 22, 1937, the two engines of this type have been working on the easily graded Budapest-Miskolc line, a distance of 115 miles, where the fastest trains they haul are allowed 2 h. 31 m., including three stops absorbing 12 minutes of the total time. The fastest run from Miskolc to Füzesabony, 35.4 miles, is accomplished in the up direction 39 minutes (54 1/2 m.p.h.); and the next tion, from Füzesabony to Vamosgyörk, 23 les, in 27 minutes (51 m.p.h.).

The locomotive has the following main mensions :

Cylinders, diameter	17 in.
Piston stroke	25 1/2 in.
Wheels, coupled, diameter	6 ft. 6 3/4 in
Wheels, bogie, diameter	3 ft. 6 in.
Boiler heating surfaces, tubes :	
Large and small.	1 160 sq.ft.
Firebox	133 sq. ft.
Total (evaporative)	1 293 sq. ft.
Superheater	379 sq. ft.
Combined heating surfaces	1 672 sq. ft.
Grate area	30 sq. ft.
Steam pressure	270 lb. per sq.
Weight of engine in working order	85.3 tons.
Adhesion weight	29.2 tons.
Tractive effort	14 300 lb.

The engine is equipped with a water p fier, tilting grate, steam heating fitti pressure adjuster for running light, mecha al lubricator, air-operated sanding gear, s recorder, and a turbo-generator for ele lighting. The water capacity of the tank 2 200 gallons, and the coal bunker holds 4 tons of fuel.

NEW BOOKS AND PUBLICATIONS.

[385.1 (494]

GENERAL MANAGEMENT OF THE SWISS FEDERAL RAILWAYS. — **Mesures de rationalisation et d'économie prises par les Chemins de fer fédéraux depuis 1920, et leurs effets financiers** (*Rationalisation and economic measures taken by the Federal Railways since 1920, and the financial results thereof).* — A pamphlet (8 × 11 ½ inches) of 40 pages, with figures, maps and tables. — 1937, Berne, Imprimerie des hoirs, K. J. Wyss, S. A.

This report is intended to inform the viss people about the financial situa-on of the Federal Railways, the causes at brought it about, and the efforts ade by the Management to improve it diminish the bad consequences.

The usefulness of the document ap-ears to be indisputable when it is re-ised that the question of transport, ch a controversial matter in so many ountries, has become so important in vitzerland that it has resulted in the awing up of no fewer than four bills law. The bill tending to reform the ganisation and the finances of the ederal Railways will probably be the ost discussed. It was therefore very portune to lay before the public a re-rt in which the true objective facts the situation are clearly explained, so at those interested might have all the formation at their disposal. In parti-lar, the reader will be able to appre-ate if the sacrifices required on be-lf of the Federal Railways are justi-d by the work they have to carry out d the measures the railway itself has plied.

First of all the public utility of the ilway system is clearly explained, and en the fact that, owing to the general onomic situation and to the competi-n of other kinds of transport, becau-of the tariff policy and the decrease traffic, the operating results became creasingly unsatisfactory from 1930 to 36. The Management of the Swiss Fe-ral Railways endeavoured to find a remedy not in increasing the rates but rather the train services, and by grant-ing special tariff concessions.

Amongst the reforms introduced in or-der to reduce the costs and increase the efficiency and flexibility of the railway, were first of all those of an organic kind. The number of divisional areas was reduced from 5 to 3. The divisions of the General Management and the area managements were reduced from 52 to 22.

Many of the general services have been centralised : the stationary service, the district accounts, medical services, etc. As regards the actual working, the station services have been completely altered, transport of goods, both parcels and complete wagon loads, has been re-organized, the goods timetables revised, the operating and locomotive staff have been amalgamated in the depots, etc. As regards the purchasing department, a central service has been introduced in place of the district offices, and 19 local stores suppressed. Similarly, the loco-motives and rolling stock department has specialised and regrouped its large shops, and also concentrated the sheds. Rationalisation has also been applied to obtain more methodical utilisation of the stock and staff.

The technical methods introduced to increase the efficiency of the staff are then described. In the offices, the use of calculating and accountancy machi-nes has been extended, and machines for perforated cards and latterly ac-

counting machines with counters have also been introduced. The important stations have been equipped with tractors, electric trolleys, or low loading trucks. The construction of interlocking signal boxes, if not always resulting in immediate economies, has made it possible to increase the safety and efficiency.

The elimination of many level crossings has resulted in expenditure only partly made good by savings on keepers; the remainder should in justice be borne by the public authorities. Where level crossings have been retained, new arrangements have made it possible to cut down the staff.

In the rolling stock department, mention must also be made of fixed train heating equipment, fixed plant for testing and filling up brakes, and the fitting of continuous brakes to goods trains. The permanent way department has developed its mechanical equipment. Electrical equipment and new signals have been installed in the electric substations.

Special mention is made of electrifica tion which, according to the detaile calculations given in an appendix, re sults in important traction economie and moreover has largely contribute towards retaining or even increasin the traffic.

After this review of the various ratio nalisation measures and improvement mentioned above, the report endeavour to estimate their effect on the annual ex penditure of the Swiss Federal Rai ways. Several appended tables make possible to follow the evolution year b year. The report ends with some detai on the kilometric costs (train-kilometr axle-kilometre, gross tonne-kilometre) i 1920 and 1936.

Everyone will be in agreement wit the final conclusion, which shows tha the steps taken to date have met wit success, and will agree that the Gener Management has fully attained its obje in laying this report before the publi

E. M.

[385 (093 (497.1)]

ARNAOUTOVITCH (Dragomir). — Graduate in Law, University of Belgrade, Doctor o the University of Paris. — **Histoire des Chemins de fer Yougoslaves** (*History of the Jugo slavian Railways* (1825-1937). — One volume (6 1/4 × 9 7/8 inches) of 366 pages with 8 inset maps. 1937, Paris, Dunod, publisher, 92, rue Bonaparte (Price, paper bound 60 francs, French currency).

Writing the history of the Jugoslavian Railways was an extremely complicated and difficulty task. The present Kingdom of Jugoslavia is formed of two former independent States and several provinces formerly belonging to other countries. The result is that the railway system is made up of lines of very various origin. The construction of these lines, moreover, came up against all sorts of difficulties. The cause thereof is to be found in the geographical and economic conditions of the regions served, the political changes which they often underwent, an the outside influences to which the were subjected.

During thirty years, the author ha had a close connection with railway in terests in Serbia and Jugoslavia. He ha collected very complete informatio from reliable sources which has made possible for him to follow the develo ment of the railways since their cre tion, both in Serbia and in the parts Jugoslavia formerly under Austrian ru

His work shows the profound effec of the most striking events in Europe

history over more than a century, especially since 1900. The subject is dealt with under the most diverse aspects, but it is above all political questions and the way the undertakings were financied that aroused the most discussions and required the greatest efforts and perseverance.

The best part of the book is the review of the period just after the War, during which the work of forming, organising and developping the present railway system is described in detail.

This book is the first noteworthy study devoted to the history of the Jugoslavian railways. Written with enthousiasm, but also with great regard to truth and accuracy, it is a very important contribution to railway literature.

E. M.

[621. 132 1 (.42)]

BARRIE (D. S.). — **Modern Locomotives of the London, Midland and Scottish Railway Company.** — A pamphlet (5 1/2 × 8 1/4 inches) of 34 pages, with 27 figures. — THE LOCOMOTIVE PUBLISHING Co. Ltd, 3, Amen Corner, London E. C. 4. (Price : 1 sh.).

This little book is published with the consent of the L.M.S. Company, and Mr. Stanier, Chief Mechanical Engineer of the Company, was goods enough to write a preface to it.

The author gives a concise review of the evolution during the last few years of the L.M.S. Railway's standardised stock of locomotives, with particular reference to the « Royal Scot » and « Princess Royal » classes, the most recent « Coronation » locomotives and the trial turbine locomotive. The standardised steam goods engines and shunting engines are also reviewed, as well as the diesel-electric shunting engines. As Mr. Stanier reminds readers in his preface, in spite of the rapid development of electric traction, the road motor and aeroplane, the bulk of the public remains deeply interested in the steam locomotive; they will much appreciate this little book whose illustrations have been selected with the greatest care, while the railway engineer will find it just as interesting on account of the accuracy of the technical data.

A. C.

[621. 132 1 (.42)]

British Locomotive Types. — One volume (6 × 9 1/2 inches), comprising 113 plates of locomotive diagrams. — Published by THE RAILWAY PUBLISHING Co. Ltd., 33, Tothill Street, S. W. 1. — 1937. (Price : 5 sh. net.)

The editor of *The Railway Gazette* has collected together in this book a series of diagrams previously published in *the Railway Gazette*, showing the outline of the principal locomotives of the English railways, as well as their leading dimensions and characteristics. The diagrams relate to both passenger and goods locomotives and shunting engines; they have all been conceived according to a standard pattern as regards giving the weight on the wheels, the wheelbase, and the dimensions of the body, boiler and tender; under each diagram there is a table giving information about the heating and superheating surfaces, the tubes, and the tractive effort.

The locomotives of each railway, given in alphabetical order, are grouped as far as possible in the same order, ac-

cording to type, so that any particular diagram can easily be found. This collection, edited with extreme care, is therefore a first-class source of information about the locomotives of the four British main-line Railways.

A. C.

[625. 2 (02]

The Railway Carriage and Wagon Handbook. — One volume (7 1/2 × 5 inches) of 366 pages, with 70 figures and tables. — THE LOCOMOTIVE PUBLISHING Co. Ltd., 3, Amen Corner, London E. C. 4. (Price : 3 sh. 6 d.)

The *Locomotive Publishing Company* has completed its well-known series of handbooks on railway stock by publishing a book giving the general principles governing the construction, repair and maintenance of passenger and goods stock. The most important chapters deal with the construction of the body, in wood or metal, and the frame and bogies of carriages, and the construction of wagons. Other chapters give very full information on the way wagons are painted, the construction of wagons by welding, the couplings, particularly automatic couplings, the running gear and springing, vacuum and compressed-air brakes, as well as on the lighting, heating and ventilation of carriages. The author also describes the principles on which shops for the mass production of wagons and shops for repairing carriages are organised according to modern planned working methods; finally he goes into the question of organising the inspection, maintenance and cleaning of carriages. This valuable handbook is completed by a great many tables giving numerical data, references to materials specifications, etc.

A. C.

CORRIGENDUM.

Bulletin, January 1938.

Article « New steam locomotives of the Austrian Federal Railways », by E. KARNER.

Page 1, 1st column, 13th line from the top :

— *Instead of :* — « its services, either by running, ...

— *Read :* « its services, or to run...